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VOLUME XXXV (1949)

CONTAINING PAPERS SUBMITTED AT THE ANNUAL MEETING IN 1949

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ANTHROPOLOGY, LANGUAGE AND LITERATURE,
MEDICAL SCIENCE, PHILOSOPHY, POLITICAL
SCIENCE, PSYCHOLOGY

PAPERS OF THE MICHIGAN ACADEMY OF SCIENCE ARTS AND LETTERS

EDITORS

EUGENE S. McCARTNEY

FREDERICK K. SPARROW

VOLUME XXXV (1949)

"Pusilla res mundus est nisi in illo
quod quaerat omnis mundus habeat."
— SENECA, *Naturales Quaestiones*

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BOTANY

A SEARCH FOR THE CORRECT COLCHICINE TREATMENT OF THE EMBRYOS OF *SCILLA SPP.* TO PRODUCE POLYPLOIDS*

WILLEM EDUARD DE MOL

INTRODUCTION

IN EXPERIMENTS with Fragaria, Nicotiana, Petunia, and Rubus, Derman (1938) proved the value of colchicine treatment of seed plants in which embryonic development takes place close to the surface of the ovary. Two years later De Mol (1940) described colchicine experiments with Bellevallia. The present paper deals with experimental methods adapted to various bulbous and tuberous plants to obtain clones with double the usual numbers of chromosomes.

Varieties of *Scilla sibirica* and *Scilla tubergeniana* were used in the experiments. These Scillae were chosen from among the bulbous plants because their exceptionally flexible flower stalks (especially *S. sibirica*) are well adapted to the method of treatment. Also, a bulb bears several stalks, each with a number of flowers. This habit provides a great many embryos per bulb. Although hyacinths have a large number of flowers, the stiffness of the stem and the arrangement of the flowers cause mechanical disadvantages in treatment. Tulips and daffodils mostly produce single flowers.

Four bulbs of *S. sibirica,* four of the triploid variety Spring Beauty (De Mol, 1942), and three of *S. tubergeniana* were potted at the end of October, 1945. Flowering started in an unheated greenhouse on the south side of the building on February 1. On February 10, after removal of the stamens, the first cross-pollinations were performed. Only the earliest flowers of two or three flower stalks were used; later ones were removed. Colchicine was applied 4, 9, 23, and 39 days after pollination.

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* *Acknowledgment:* The author is indebted to the University of Amsterdam for laboratory facilities and to Dr. Teunis Vergeer, of Hope College, Holland, Michigan, for valuable assistance in the preparation of the manuscript.

Two methods of treatment were employed:

(1) A drop of the colchicine solution was placed on the ovary after the anthers had been completely removed. The surrounding petals were relied on to hold the solution in contact with the ovary. This method is satisfactory only while the petals remain turgid.

(2) The flower stalk having only the ovaries is bent into a small tube containing the colchicine solution and is held in place with a plug of cotton. This method prevents evaporation, and therefore little of the solution is lost. As controls, a number of flowers without stamens were allowed to develop naturally. Since experiments by other workers have proved that 2 per cent colchicine is effective, this amount was used in these experiments.

TABLE I

S. TUBERGENIANA ♀ × S. SIBIRICA ♂

Date of pollination	Date of treatment	Days between pollination and treatment	Treatment in hours	Method	No. of flowers	Ovary March 28	Ovary April 10	Yield May 15
Feb. 10	Feb. 14	4	6.5	Drop applied	1	Some swelling	Died off	None
Feb. 10	Feb. 16	6	24	Drop applied	1	Became yellow	Died off	None
Feb. 10	Feb. 18	8	9	Tube	1	Became yellow	Died off	None
Feb. 11	Feb. 15	4	48	Drop applied	1	Withered		None
Feb. 11	Feb. 17	6	7	Tube	2	Some swelling	Died off	None
Feb. 17	Feb. 23	6	6	Tube	3	No swelling	Died off	None
Feb. 18	Control	..	..	..	5	Normal swelling	Four died off	Three seeds

TABLE II

S. TUBERGENIANA ♀ × ♂ (SELF-POLLINATED)

Date of pollination	Date of treatment	Days between pollination and treatment	Treatment in hours	Method	No. of flowers	Ovary March 28	Ovary April 10	Yield May 15
Feb. 10	Feb. 14	4	4	Drop applied	1	Some swelling	Died off	None
Feb. 10	Feb. 16	6	6	Drop applied	1	Some swelling	Died off	None
Feb. 10	Feb. 18	8	8	Tube	2	Some swelling	Died off	One seed
Feb. 13	Feb. 19	6	6	Tube	1	Became yellow	Died off	None
Feb. 15	Feb. 19	39	14	Tube	3	Normal swelling	Normal swelling	Three seeds
Feb. 10	Control	..	..	..	1	Some swelling	Died off	None

The results of pilot experiments to determine the most favorable time lapse between pollination and treatment, the best length of exposure, and the most favorable crosses are given in Tables I–VI.

Tables I and II show that only very few seeds came to full development. This was true, however, of the controls and of the open-ground seed yield of these species. For example, in 1945 only 26 seeds were harvested from 16 deliverable bulbs. For the remaining experiments a species or a variety was used which, under normal circumstances, yields seeds abundantly. The temperature at which the crossings were performed was 3°–4° C., which was low.

The forming of the embryo under the influence of the solution probably took place only in the case of treatment after 8 days for 8 hours. Further breeding will determine this. The treatment for 14 hours 39 days after pollination is of very questionable value. Because of their low fertility these crosses were not repeated.

TABLE III

S. SIBIRICA ♀ × S. TUBERGENIANA ♂

Date of pollination	Date of treatment	Days between pollination and treatment	Treatment in hours	Method	No. of flowers	Ovary March 28	Ovary April 10	Yield May 15
Feb. 29	March 8	8	1	Tube	3	Normal swelling	Normal swelling	Seven seeds

TABLE IV

S. SIBIRICA ♀ × S. SIBIRICA VAR. SPRING BEAUTY ♂

Date of pollination	Date of treatment	Days between pollination and treatment	Treatment in hours	Method	No. of flowers	Ovary March 28	Ovary April 10	Yield May 15
Feb. 23	March 1	7	5	Tube	2	Normal swelling	Normal swelling	Seven seeds
March 5	March 9	4	4	Tube	3	Normal swelling	Normal swelling	One seed
Feb. 23	Control	..	..	..	3	Normal swelling	Normal swelling	Eight seeds

Since Tables III and IV show that *S. sibirica* sets seed more easily than *S. tubergeniana,* the experiments with it will be continued on a larger scale.

A period of four days between pollination and treatment is not too short for embryo formation. In the experiment, however, only one seed resulted from three flowers. When seven days were allowed to elapse between pollination and a treatment, seven seeds developed from two flowers.

It would appear, then, that there are about five days between pollination and embryo formation in S. *sibirica.* New experiments are needed to answer this question.

It is interesting to note that pollen of Spring Beauty is fertile enough to produce considerable seed in spite of the fact that it is triploid (De Mol, 1942).

Table V shows that a cross between Spring Beauty and S. *tubergeniana* as the male parent is also sterile, even when ample time is allowed for the formation of the embryo (23 days).

TABLE V

S. SIBIRICA VAR. SPRING BEAUTY ♀ × S. TUBERGENIANA ♂

Date of pollination	Date of treatment	Days between pollination and treatment	Treatment in hours	Method	No. of flowers	Ovary March 28	Ovary April 10	Yield May 15
Feb. 22	Feb. 29	7	2	Tube	2	Some swelling	Died off	None
March 2	March 25	23	5	Tube	2	Some swelling	Died off	None

TABLE VI

S. SIBIRICA VAR. SPRING BEAUTY ♀ × S. SIBIRICA ♂

Date of pollination	Date of treatment	Days between pollination and treatment	Treatment in hours	Method	No. of flowers	Ovary March 28	Ovary April 10	Yield May 15
Feb. 22	March 2	9	2	Tube	1	Some swelling	Died off	None
March 8	March 12	4	1.5	Tube	2	Normal swelling	Died off	Three seeds
March 23	March 30	7	6	Tube	2	Normal swelling	Died off	Two seeds
March 28	April 4	7	6	Tube	2	Normal swelling	Died off	Three seeds
March 8	Control	..	..	..	2	Normal swelling	Died off	Eight seeds

Table VI shows that, in spite of colchicine treatment, seeds form fairly readily from S. *sibirica* var. Spring Beauty when crossed with the original species.

Treatment of 1.5 hours does not markedly interfere with embryonic development when only 4 days are allowed to pass between pollination and treatment. Potentially, normal *S. sibirica* can produce 20 embryos from an ovary. Since few seeds were obtained, it is believed that they developed in spite of the colchicine treatment. They cannot at this time be sacrificed for microscopic examination, and only culture can determine whether polyploid embryos resulted from the treatment.

SUMMARY

Of the bulbous plants, *Scilla sibirica* was found to be best adapted for treatment by colchicine. Crosses of *S. tubergeniana* ♀ with *S. sibirica* ♂ proved almost sterile, as was the self-fertilized *S. tubergeniana.* Crosses of *S. sibirica* ♀ with *S. tubergeniana* ♂ were more productive. Crosses of *S. sibirica* ♀ by *S. sibirica* var. Spring Beauty ♂ yielded good seed, as did reciprocal crosses.

From the study of several crosses it appears that four days must elapse between pollination and treatment if any seed is to develop, but more seed results if an interval of seven days is allowed. Partial inhibition of seed formation is interpreted as an indication of the effect of colchicine.

The duration of exposure to 2 per cent colchicine extended from one to forty-eight hours. Treatment as short as one and one-half hours reduced the normal seed yield.

AMSTERDAM, THE NETHERLANDS

LITERATURE CITED

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—— 1942. Die erste gezüchtete Triploide *Scilla sibirica* Andrews. Die Gartenbauwissenschaft, 17, Heft 3:227–239.

DERMAN, H. 1938. A Cytological Analysis of Polyploidy Induced by Colchicine and by Extremes of Temperature. Journ. Hered., 29:210–229.

TWENTY-FIVE YEARS OF TULIP IMPROVEMENT BY X-RAY*

WILLEM EDUARD DE MOL

INTRODUCTION

THE history of the European culture of tulips dates back nearly four centuries, when the first were imported from Turkey. In 1581 Matthias de Lobel described twenty-two varieties in his *Kruidtboeck* ("Book of Herbs"). The first mention of sowing tulip seed was made by Chrispyn van de Pas in 1636. In the seventeenth century Dutch "tulipmania" reached the point at which 11,500 guilders, or about $4,600, was paid for a single bulb of a new variety. Double tulips were first recorded in 1665. Parrot tulips were known before 1800. The Darwin tulips that are popular at present were largely originated by hybridization; others arose by mutations and were recognized as such during the early part of this century, when the author first undertook the study of bulb culture. Early experiments with X-ray treatment of tulips produced the mutation Sparkling Pitt from the tulip William Pitt (Pl. I). Because it combined several improvements in one flower (see below) it markedly stimulated interest in this manner of producing mutations.

SPONTANEOUS MUTATIONS

Mutations in flower bulbs are no surprise to the grower or the experimenter. During a culture of many years spontaneous changes have been observed under field conditions. These mutated plants were isolated and multiplied vegetatively; they have preserved the mutated quality. Most of them have been propagated in great quantities as precious assets and, together with the mother varieties, have been marketed for many years; for example, Cordell Hull, Bonifacius, Merula, Monarch, Hudson, Hilde-

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* *Acknowledgment:* The author is indebted to the laboratories of the University of Amsterdam and to Philips Ltd., Electric Works, Eindhoven, Netherlands, for the use of X-ray equipment and other facilities, and to Dr. Teunis Vergeer, of Hope College, Holland, Michigan, for valuable assistance in the preparation of the manuscript.

brand, Sedan, Tindal, and Unitas have been grown from the red Darwin tulip Bartigon. They represent as many somatic mutations in color from pink to red.

MUTATIONS DUE TO ALTERATION OF TEMPERATURE

That high- or low-temperature treatment during storage results in genetic changes was also established during the first quarter of this century (De Mol, 1929).

X-RAY MUTATIONS

Roentgen rays were first used in 1922. They appear to cause the same mutations as those which originate spontaneously in the field or by modi-

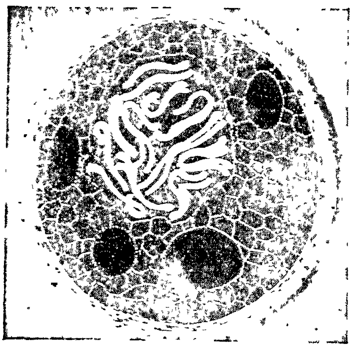

FIG. 1

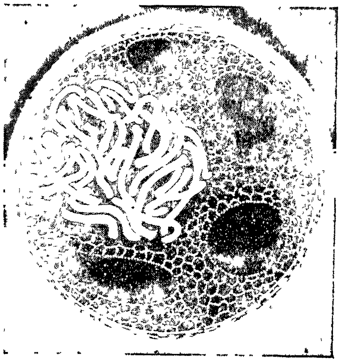

FIG. 2

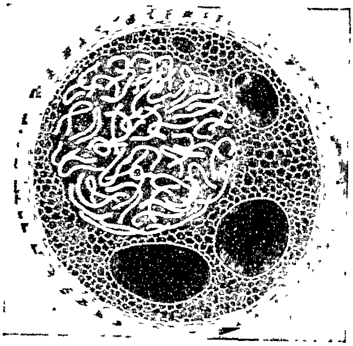

FIG. 3

FIGS. 1–3. Haploid, diploid, and tetraploid pollen of tulips. Pollen grains progressively larger, but all figures are enlarged to same size. Photographs by J. Agterberg fication of temperature, but they evoke the natural potentialities of tulips much more easily. The treatment is a valuable means of improvement for both the grower and the experimenter, but it cannot in one year produce bulbs with the desired characteristics. The mutation generally first appears as an aberration in color or shape in a single sharply defined sector of a normally colored petal. During the development of the plant in spring new small bulbs grow between the withering scales. They originate from the buds present at the time of planting in October of the preceding year. When these buds are in the mutated sector, the new bulbs retain this feature. One may note from year to year the gradual spread of the mutated characteristic, first to a perianth leaf, then to a sector of the plant, and finally to the whole plant (Pls. II–III).

Between 1928 and 1935 it was discovered that X-raying of hyacinths causes slow and feeble growth and that X-raying of tulips and hyacinths may result in doubling or quadrupling the number of pollen grains (Figs. 1–3). Microscopic studies showed that (1) the number of chromosomes varied owing to the arrest of nuclear division, (2) chromomeres separated from their chromosomes and often were stretched out into filaments, (3) chromosomes remained in the cytoplasm after nuclear reconstruction, (4) many pollen grains became sterile, and (5) somatic mutations also occurred (De Mol, 1933, 1937).

By 1940 the practical application of X-ray treatment had resulted in seventy-two distinct characteristics. The most notable among these represent modifications of the amount of anthocyanin, a blue, violet, or red pigment found dissolved in the cell sap. The variety Dido changed from orange pink to a lighter shade; Prosperity turned pink instead of white; Fantasy changed from pink to red; William Copland, from violet to pink; Roi d'Islande, from pink to violet. Yellow plastids formed in the dark-pink tulip Peach Blossom. Its mutation shows a mixture of red and yellow.

The color of the leaves is often modified; for example, Prince of Austria has a light-green edge, and Fantasy has developed a yellow stripe in the middle of the leaf, whereas green and yellow stripes alternate in Peach Blossom and Gemma (Pl. IV).

The shape of the flowers shows various aberrations after treatment; among them the edge of the perianth leaves is ragged in Van der Neer, the flower has become more globate in Roi d'Islande, the perianth leaves have sharper points in Clara Butt. The Parrot tulips are X-ray bud mutations whose perianth leaves have been enlarged from the normally formed General de Wet (Pl. V). The Parrots Gemma and Fantasy prove that this process is not irreversible; by continued treatment they have been reduced to the normal flower shape. Fantasy and Red Champion have also developed different shapes and colors (Pl. VI, Fig. 1).

Several mutations may combine in a single new tulip. Sparkling Pitt is a sparkling dark-red bud mutation of the lighter-red William Pitt. The color is finer than that of the mother variety, and the flower, originally rounded off on the under side, has become somewhat squat, and a so-called butterfly heart[1] has developed at the base of the perianth leaves (Pl. I). It is an adornment to bulb culture, an asset to the trade, and an achievement of science.

In the hyacinths partial staminody, the partial metamorphosis of perianth leaves into stamens, has occurred. The three inner perianth leaves have become shorter and narrower. To the right and left the darker-colored tissue of the anthers is visible. At maturity this tissue bursts, and the yellow pollen appears. When microtome sections are made from these abnormally formed perianth leaves while they are young, one may clearly see the (sterile) pollen grains under the microscope.

The total number of mutations in hyacinths and tulips obtained after twenty-five years of X-ray treatment surpasses many times the number reported in publications.

Though even the smallest and least attractive deviations are important to science, only those varieties having a market value are raised on a large scale. Since 1940 a number of "X-ray tulips" without commercial value have been preserved by the author in a so-called Hortus Bulborum maintained for scientific research. Only one of the hyacinth mutations is still being propagated, since such culture is very expensive.

TEMPORARY MODIFICATIONS

In addition to permanent mutations, X-ray often results in modifications of a passing nature. During the first two years the X-rayed plants show, on the whole, a damaged aspect and an impaired growth (Pl. VI, Fig. 2). Though the amount of treatment has a definite influence on this phenomenon, such changes are bound to happen even with well-determined doses. The structure of the tulip bulb explains why plants appear to suffer most in the first two years after radiation. During the X-raying between July and November there exists in the bulb a large bud with a much smaller bud at its base. The first or final bud has progressed farthest and already contains the leaves and the flower for the next year.

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[1] A yellow-white band above the blue spot at the base of the perianth leaves.

The smaller bud is a new starting point for the second year, with several small scales already split off. This bud also is reached by the X-rays and, when in the second year it grows into a plant, it still bears traces of the previous treatment. The buds which at the time of treatment had not developed show the mutated form, but develop more normally.

DIVISION HYPOTHESIS

The radiant day of April 24, 1937, will not easily be forgotten by the author. Dr. L. Randolph, of the Cornell University Agricultural Experimental Station, had asked permission to attend some experiments. In the laboratory he found a plant in full bloom; it was the tulip Prosperity, of which one half of the flower was dark red, whereas the other half was pure white.

To explain this result of X-ray treatment I proposed the division hypothesis (De Mol, 1942). The ordinary Prosperity has a pink flower. The process of division of the genes for pink had been hindered. When the mother nucleus divided into two daughter nuclei, these genes were kept in one daughter cell by the X-raying (duplication of genes) and consequently were not able to reach the other one (deletion). This daughter nucleus could not develop a pink anthocyanin; hence the white half of the flower. The first daughter nucleus, on the other hand, received all the genes for pink; hence the red half of the flower (cumulative effect). Many cases of bud mutation can be explained by duplication and deletion.

The origin of other modifications may be explained similarly. When the external conditions influence the cell in a uniform way, with the result that the division — albeit disturbed — proceeds equally, a modification lasting one or more years occurs. With an unequal influence and an inharmonious course of the division, cells with too many or too few chromosomes or chromosome fragments originate. This influence on the cytoplasm then causes the hereditary diversity.

SUGGESTIONS FOR X-RAY TECHNIQUE

The technique, experimentally developed since 1922, not only takes into account the doses, quality, and duration of the treatment, but also, and more especially, the phase and development rate of the bulb. This, of course, is closely related to the particular variety to be treated. During the first years tulips were exposed to various dosages of X-ray up to 1,000 roentgen units. After repeated experiments it was established that it was not wise to surpass 800 roentgen units.

The effects of the hardness of the rays showed plainest in Krelage's Triumph, in which the heaviest damage corresponded with the highest voltage. Full-grown large bulbs treated in August and September proved most satisfactory. They contain the greatest number of buds and young bulbs and, because of their dryness and hardness, are better protected against damage during transport and X-ray treatment.

If one wishes to bring out all the possible mutations and all the possible genetic changes in the bulbs that may result from one treatment, he should propagate them for at least four years.

SUMMARY

The history of mutation in tulips is reviewed, and the results of X-ray treatment since 1922 are summarized. Concurrent nonhereditary aberrations are discussed. A "division hypothesis" based on duplication and deletion is reviewed. Treatment in August and September with dosages not in excess of 800 roentgen units are most successful.

AMSTERDAM, THE NETHERLANDS

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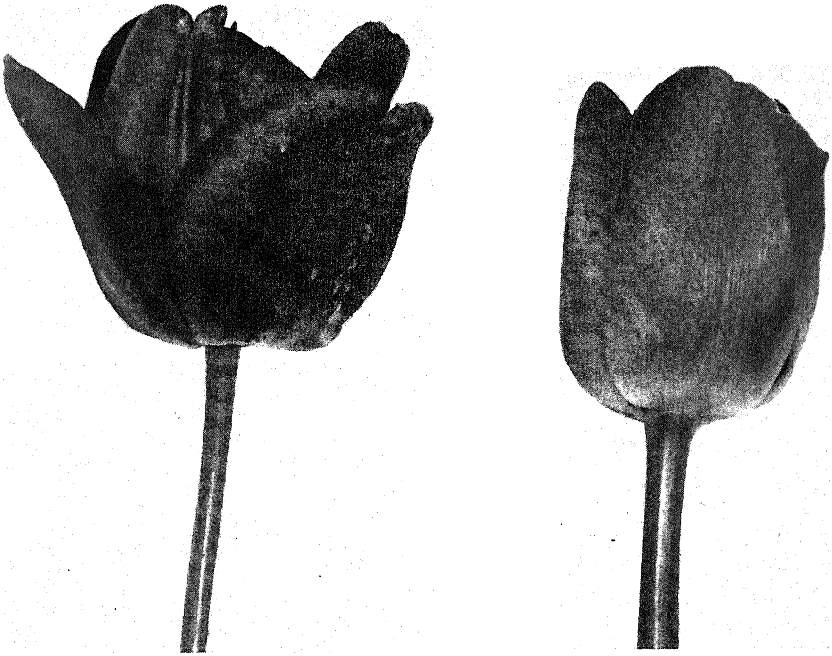
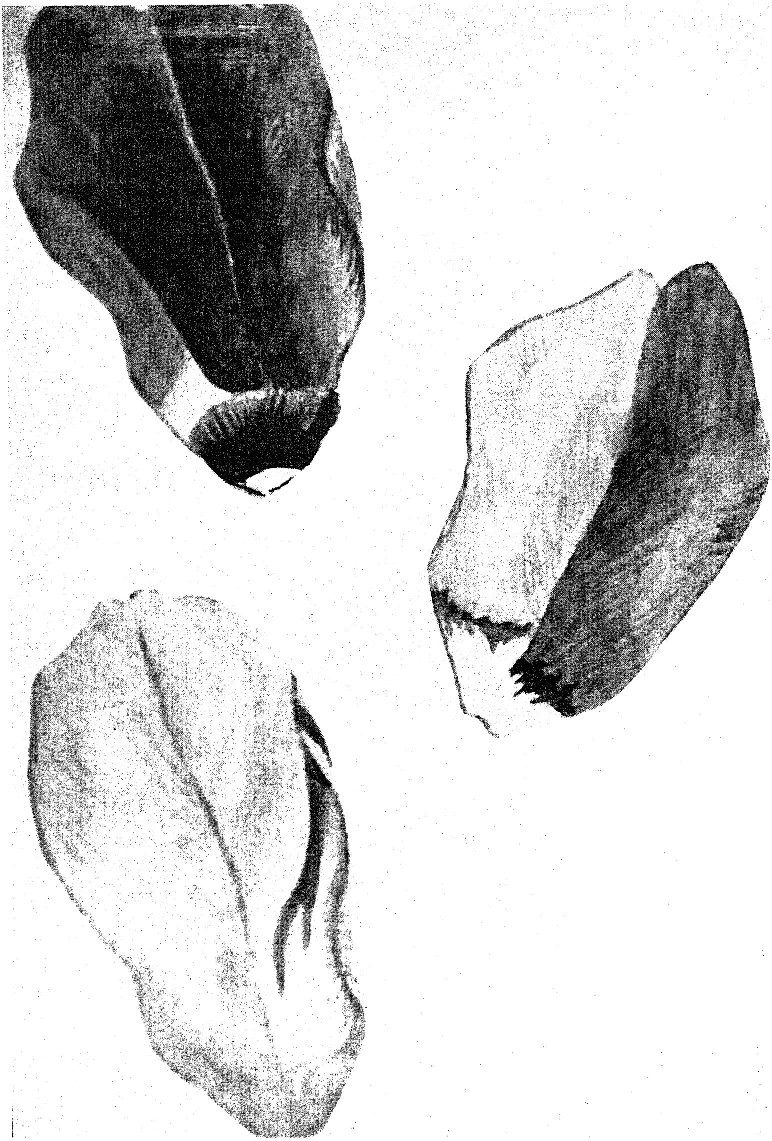


Red Darwin Tulip William Pitt (right) and its X-ray mutation, Sparkling Pitt
(Photograph by J. Agterberg)



X-ray mutations in petals. Upper: Red, white and yellow sectors in a petal of Darwin Tulip Alland Pierson. Middle: Lighter sector in Darwin Tulip Bartigon. Lower: Small red sector in Mon Tresor. (From water colors by E. Loudon. Photograph by George Schneider)

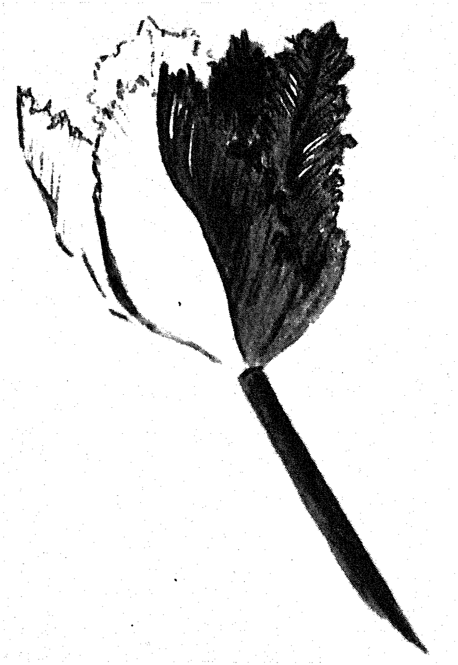


FIG. 1

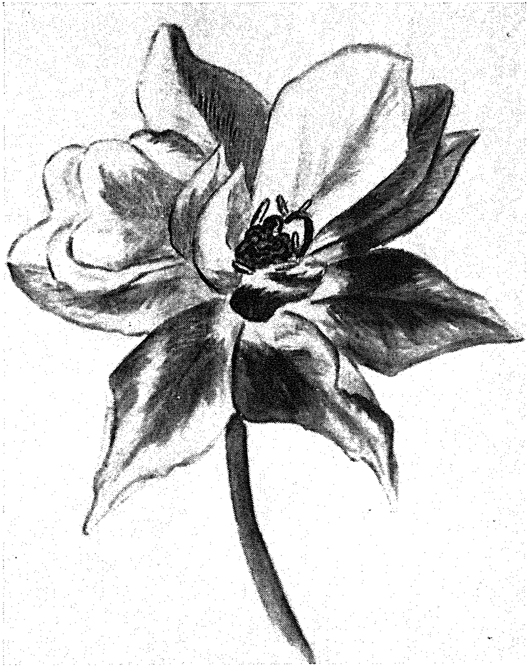
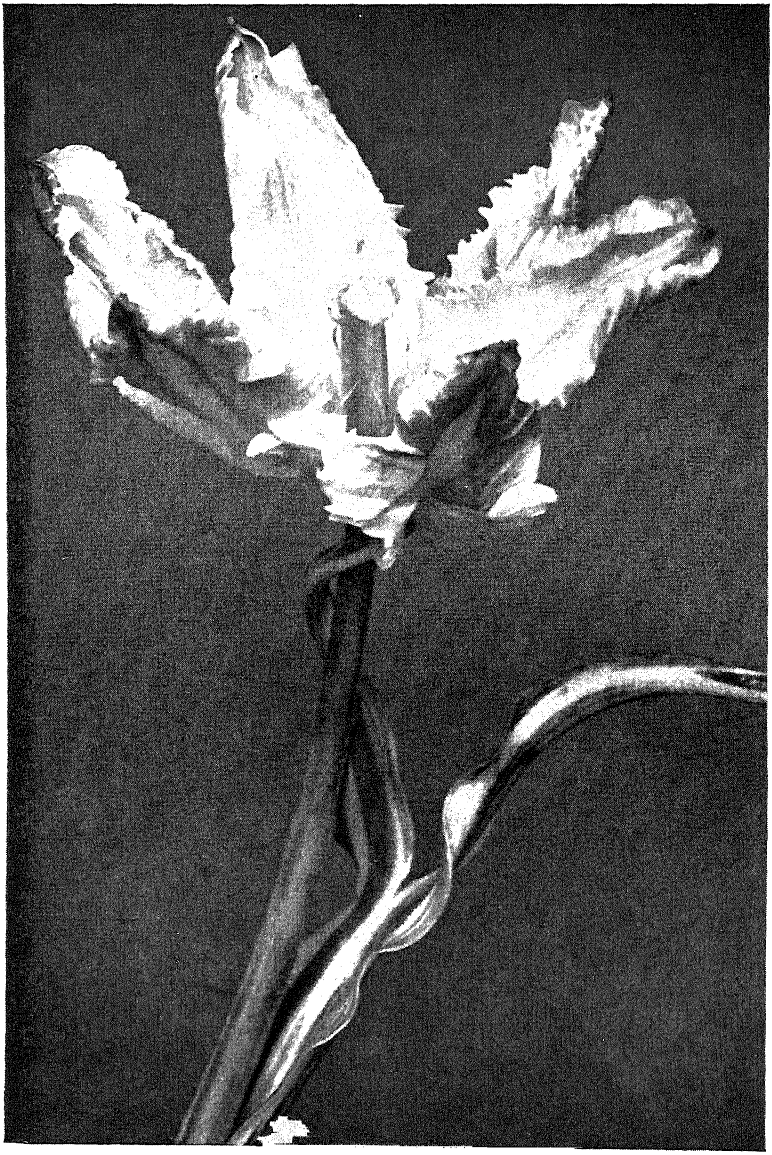


FIG. 2

White X-ray mutations in half of Parrot Tulip Red Champion (Fig. 1) and in half of Early Tulip Peach Blossom (Fig. 2). From water colors by E. Loudon. (Photographs by George Schneider)



Variegated leaf of Parrot Tulip Gemma
(Photograph by C. A. van der Gen)

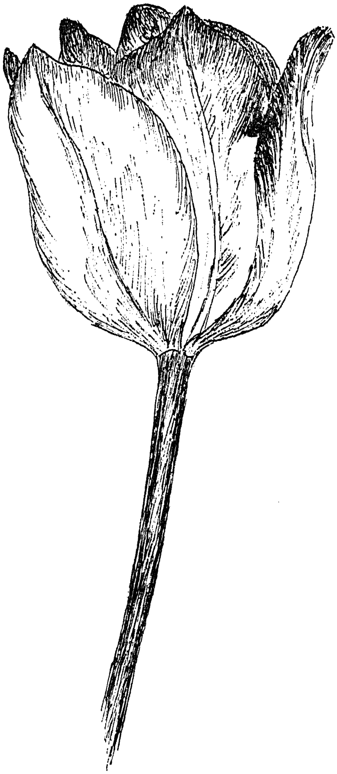


FIG. 1

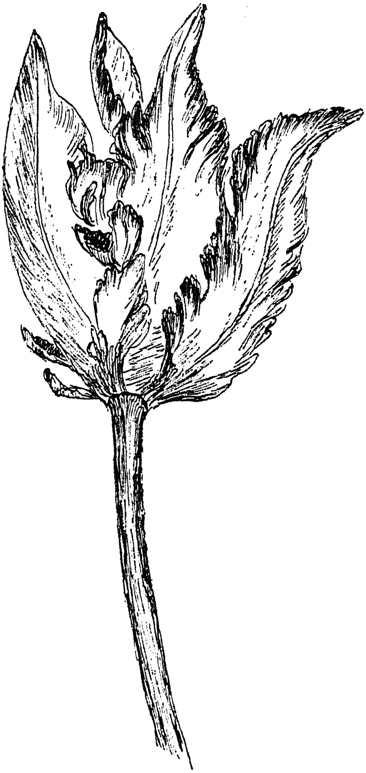


FIG. 2

FIG. 1. Single Early Tulip General De Wet. Drawing E. Loudon
FIG. 2. X-ray mutation form General De Wet to Parrot form

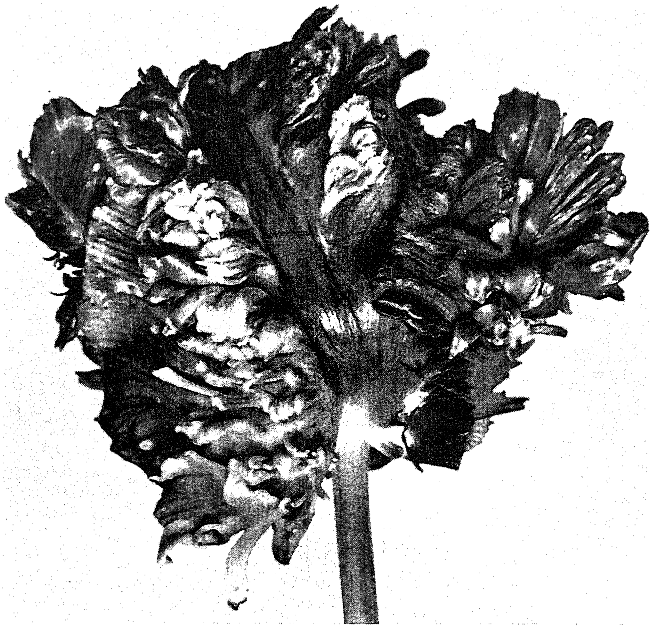


FIG. 1. Giant X-ray Tulip Red Champion
Photograph by J. Agterberg

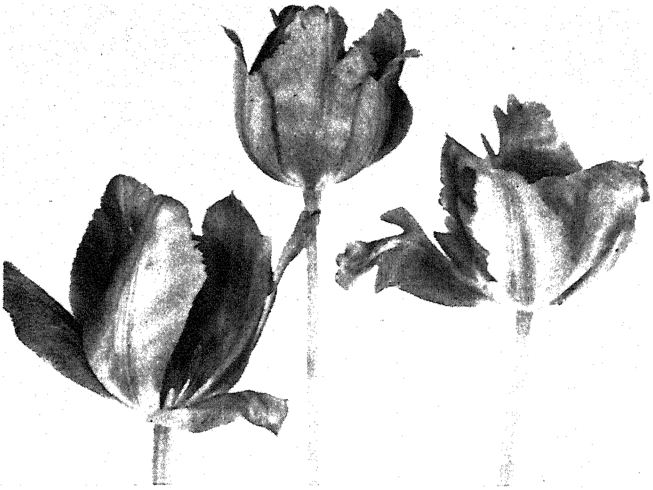


FIG. 2. Aspect of damaged tulips the first year after X-ray treatment. (Photograph by Agterberg)

THE EFFECT OF SIX VITAMINS UPON THE GROWTH OF *FUSARIUM SOLANI* IN A SYNTHETIC MEDIUM

SISTER MARY VIRGIL GHERING

THE culture of *Fusarium solani* used in this investigation was identified by Professor William C. Snyder,[1] of the University of California. It was carried on a potato-dextrose agar. Spore suspensions were made with a 5 per cent solution of peptone in normal saline, and were stored in a refrigerator. It had been reported to the author that such suspensions could be kept indefinitely under these conditions, but germination was observed after a few weeks, when spore counts were made with a hemocytometer.

Every component of the nutrient medium employed was chemically defined. A mixture of amino acids replaced the "vitamin-free" casein hydrolysate, which is used in many of the microbiological procedures for the assay of various vitamins. Hydrolysis of casein is usually effected by heating with strong acids, but it is doubtful whether the reaction is ever complete. The products of hydrolysis include, besides the alpha-amino acids, ammonia and humin. Tryptophane is lost in the insoluble humin fraction, while tyrosine is involved in the soluble brown humin. If hydrochloric acid is used, some cystine is destroyed in the subsequent removal of chloride ions by means of silver salts. Ordinary technical casein contains a considerable amount of vitamins. To remove completely traces of niacin and other vitamins, the casein is subjected to treatment with special activated carbons. The adsorption of amino acids and peptides by activated charcoal has been reported. It is probable, therefore, that casein hydrolysate varies from lot to lot according to the content of the original casein, the extent of hydrolysis, and the amount of treatment by norite for the removal of vitamins.

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[1] Snyder and Hansen (1945) have proposed a revision of the taxonomy and nomenclature of the Fusaria. Their system is based upon evidence of variability, occurring in the progeny of cultures isolated from single spores of many so-called species in the genus.

Some microorganisms are able to synthesize all the amino acids they require from a single one or from asparagine. They display better growth, however, when a mixture of amino acids is furnished in equivalent amount in the culture medium. Robbins and Ma (1945) suggest that substances which are supplied in the medium may be incorporated into fungal proteins more rapidly than those which must be synthesized by interconversions in living tissue. Many fungi require a complex nitrogen source. The nitrogen requirements of these organisms are determined by omitting one component at a time from a mixture of amino acids which supports growth. When all the nonessential components are omitted at the same time, however, growth seldom results. Under these conditions additional amino acids are indispensable. Snell (1946) recommends the use of a complete assortment of amino acids for both vitamin and amino-acid assay.

The optimal combination of amino acids is not known. Since casein is the protein having most satisfactory nutritive properties, a synthetic casein hydrolysate has been widely used. However, it is not certain that casein supplies all the amino acids in ideal proportions. It is considered likely that the minimum protein requirement, as determined by the optimal combination of amino acids, may prove to be much lower than that secured with casein.

The amino-acid requirements of *Lactobacillus arabinosus* and *L. casei* were investigated by Hyma (1946). He used Snell and Wright's medium (1941) for the assay of niacin and Gladstone's medium (1937) as points of departure. Hyma tried more than five hundred combinations of amino acids, and as a result of his work formulated the amount of each one which gives maximum growth of the test organisms. This was the mixture used in the present investigation. It included the twenty commonly occurring amino acids plus the purine bases, adenine, guanine, and xanthine; the pyrimidine base, uracil; and asparagine. Asparagine has been reported to accelerate growth, especially in the earlier stages. The other substances have been shown to be accessory growth factors for the lactic-acid bacteria. Because of the fundamental unity which underlies all biochemistry, it is very likely that they act as growth-promoting substances for other organisms as well.

The stock mixture of amino acids was kept in a tightly stoppered brown bottle. As compared with casein hydrolysate, it is a very convenient nitrogen source. Casein hydrolysate contains no preservative; therefore the solution remaining in the bottle must be sterilized each time the stopper is removed. We did find it possible, however, to withdraw the solution with a sterile hypodermic needle and thus eliminate the need for repeated sterilization.

A comparison of the relative values of asparagine, casein hydrolysate, peptone, and the amino-acid mixture is indicated in the tubes of Figure 1.

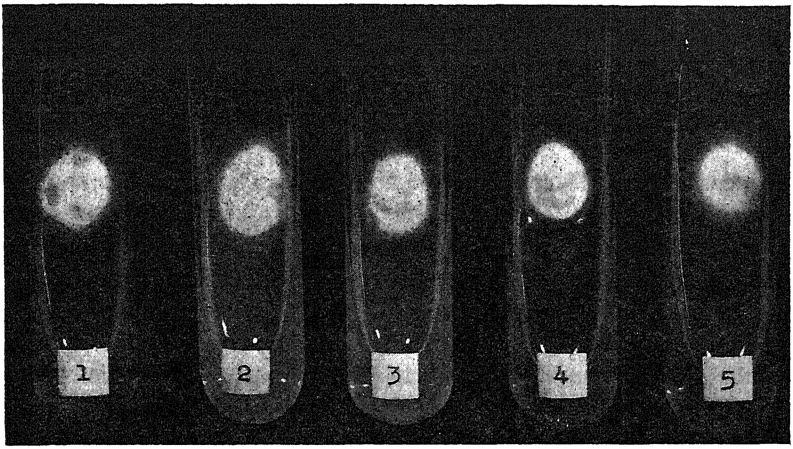

FIG. 1. A comparison of the effects of nitrogen from various sources upon the growth of *Fusarium solani* after six days on an agar medium containing sugar, salts, and asparagine. Tube 1 contained 8 mg. neopeptone; tube 2, 60 mg. casein hydrolysate; tube 3, 360 mg. casein hydrolysate; tube 4, 62 mg. amino-acid mixture. No addition was made to tube 5

Each tube contained eight milliliters of an agar medium made up of sugar, salts, and asparagine. To tube 1 was added peptone; to tube 2, casein hydrolysate in lesser concentration; to tube 3, casein hydrolysate in greater concentration; to tube 4, the amino-acid mixture. No addition was made to tube 5. The asparagine medium yielded a thin, spreading growth on the surface of the agar. The amino-acid mixture was not greatly inferior to the natural products when either extent or character of growth was considered. The edges of the colony, however, were more sharply defined. Casein hydrolysate in greater concentration gave less good growth than casein in lesser concentration. The latter produced the best growth if judged on the basis of diameter of colony, but peptone excelled in character of growth.

In this experiment it was observed that a deep-red pigment suffused throughout the peptone medium; but in the medium containing the amino-acid mixture not the slightest trace of pigment was produced. The asparagine medium acquired a pinkish-orange cast, and the casein-hydrolysate medium became pink. A deeper shade of color developed in the medium which contained the lesser concentration.

Subsequently the fungus was cultured on an agar medium with the amino-acid mixture as the nitrogen source and in the presence of single vitamins. Little difference was observed so far as colony diameters were concerned; but the presence of the vitamins, except p-aminobenzoic acid, seemed to encourage the spread of hyphae in the medium. No pigment was observed in any of the tubes except those which contained biotin and i-inositol. In the presence of these substances the medium became a deep-rosy red. It does not seem rash to suggest that the production of pigment in the media containing peptone and casein hydrolysate was due to the presence of vitamins in them. Many workers have reported the occurrence of various vitamins in peptone. After several weeks a faint-pink color was observed in all the tubes, except that containing p-aminobenzoic acid. If the production of pigment is evidence of the presence of biotin or i-inositol in the medium, their occurrence may be explained by the ability of the fungus to synthesize them at a very slow rate.

The initial pH of the medium seemed to have little effect upon the growth of the fungus. According to Wollenweber and Reinking (1935), this phenomenon is not unknown among the Fusaria. A potassium-citrate buffer was employed. The presence of the buffer in the medium resulted in a marked increase in growth, which seemed to be out of proportion to its effect upon the pH of the medium. It has been reported that beta-alanine is active only in the presence of biotin, thiamin, asparagine, and glutamic acid. Organic acids, however, and citric acid in particular, can replace the asparagine and glutamic acid. Citric acid reduces the optimal concentration of beta-alanine to a tenth of the usual amount.

The determination of the effect of a vitamin upon the growth of the fungus was practically the same procedure that is employed in microbiological assays of vitamins. A basal medium was prepared containing all the vitamins except the one under test. The sugar, salts, and amino acids were dissolved in distilled water over a steam bath. Appropriate amounts of the trace salts, buffer, and vitamin solutions were added, and the volume was brought to one liter. The solution was divided into ten portions, and the vitamin under test added in amounts calculated to give the desired concentrations. Biotin and folic acid were added after sterilization. The stock solutions of these vitamins were made up with sterile distilled water, and were stored in a refrigerator.

The volume of nutrient solution employed for culturing the test organism was 25 milliliters in 125-milliliter Erlenmeyer flasks. A standard loop was used for inoculation. One loopful of the spore suspension was the standard inoculum for both the liquid cultures and the agar slants. The cultures were agitated after inoculation, but were incubated without agitation for six days at 27° C. Growth was determined by autoclaving the cultures, filtering, and drying the mycelial mats to constant weight at 100° C. The filter papers had previously been numbered, folded, and dried on watch glasses to constant weight. They were stored in a desiccator.

No vitamin proved to be essential for growth of *Fusarium solani.* Biotin, folic acid, and calcium pantothenate, however, stimulated growth. When the average dry weight of mycelium in milligrams was plotted against the concentration of these vitamins in gamma per milliliter, S-curves were obtained. The stimulatory effect of these vitamins may be due to the inability of the fungus to synthesize them as rapidly as they can be used if furnished from the outset in the culture medium.

It is not surprising that biotin should exert a beneficial effect upon growth. Barnett and Lilly (1947) secured some evidence that the ratio of the weight of biotin in the medium to the weight of mycelium at the time of perithecial formation must be at least one part to twenty million for perithecial formation to occur. Folic acid may be synthesized by microorganisms in the digestive tract. Persons getting sulfa-drug treatment occasionally develop a white blood cell deficiency. The same type of blood disorder appears in persons who have been deprived of folic acid. Elvehjem (1943) suggests that the sulfa drugs may destroy the microorganisms in the intestinal tract which ordinarily manufacture folic acid. In view of the almost universal occurrence of pantothenic acid in tissue extracts, the slightly beneficial effect of calcium pantothenate is not difficult to understand.

These experiments indicate that pyridoxine and riboflavin are without effect upon the growth of *Fusarium solani.* Pyridoxine was discovered in studies of animal nutrition, and with the exception of a few species of Ceratostomella, fungi do not require it. Hawker (1944) stated that riboflavin, niacin, and the fat-soluble vitamins had not so far been reported essential for the growth of any fungus, although some species were known to synthesize one or more of them. It may be that they play a rôle in the biosynthetic processes of fungi, but that all fungi are able to synthesize them.

Niacin seemed to exert an injurious effect upon growth, which was greater in the absence of niacin than under any other condition of the experiment. This might be due, however, to changes in the composition of the medium during heat sterilization. Knight (1945) affirms that heating asparagine and glutamic acid together in the presence of manganese and air yields nicotinamide, which was identified by isolation and characterization. Since these substances were present in the medium, it may be that the harmful effect of niacin was due to its presence in excess.

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SOME NUTRITIONAL ASPECTS OF THE PISTILLATE CONDITION IN RAGWEEDS *

KENNETH LESTER JONES

THE giant ragweed, *Ambrosia trifida* L., is monoecious with pistillate flowers in the leaf axils and staminate flowers in conspicuous racemes. I have not seen deviations from this pattern in nature.

In 1945 I collected in one locality along the Huron River near Ann Arbor, Michigan, seed infested with larvae. The following spring sixty-four plants were grown from them, eight of which bore some pistils in the racemes. The leaves were misshapen and blotched with yellow areas.

I was then carrying on photoperiod experiments and found, as had Mann (1942), that plants of *A. trifida* given six hours of light a day produce pistillate structures in place of staminate. The seed that occasionally form from such abnormally developed pistils are about one third the usual size. It happened that the first that I succeeded in germinating grew into dwarfed plants with misshapen leaves (Pl. I, Fig. 1) and pistillate racemes.

These observations suggested that sex reversal may be brought about by a deficiency of food in the cotyledons. A simple experiment was therefore run to test the effect of the removal of cotyledons from normal seedlings. Carefully selected seed were sown on June 11, 1947, and the plants were grown in the greenhouse under normal light conditions of the summer season. The results are given in Table I.

The occurrence of a few aberrant plants in the control was hardly expected, since I had encountered none either in nature or under ordinary conditions of cultivation. No significant increase in sex reversal was brought about by the removal of cotyledons or plumule. (Plate I, Figure 2, shows some of the altered racemes.) I had previously reported (1936) that in Form 2 of *Ambrosia elatior* excision of the plumules increased the pistillate plants by 6.4 per cent.

In the meantime additional information has been obtained on the offspring from seed of sexually reversed plants from the photoperiod work. Such minute seed do not, as first supposed, ordinarily form individuals with pistillate racemes. To date (April, 1949), 230 plants have been grown and only 7 have borne racemes with pistillate flowers. Dwarfing is likewise not the rule, since only 6 plants showed this condition, 3 being pistillate.

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* Paper from the Botanical Gardens and the Department of Botany, University of Michigan, No. 894.

Pruning and defoliating of plants in which floral primordia have formed appreciably increases the percentage of sex reversals (Table I).

TABLE I

THE FORMATION OF RACEMES WITH PISTILLATE HEADS IN AMBROSIA TRIFIDA

Material	No. of plants	With racemes	Racemes pistillate	Percentage pistillate
Control	100	96	1	1
Cotyledons removed	100	91	3	3
Plumule and cotyledon removed	102	85	2	2
Pruned	50	46	6	12
Defoliated	109	48	14	12
Defoliated, sucrose	71	24	5	7

The pruned plants were cut back to bear only one leafy branch. The plants that were defoliated were grown as individuals with two equal, opposite branches; one branch was left intact, and the other was completely defoliated when floral primordia appeared. As Table I indicates, over 50 per cent of the defoliated branches failed to produce racemes. The foliated branch always gave rise to staminate racemes.

A second set of defoliated plants was sprayed with a 10 per cent aqueous solution of sucrose in which "carbowax" was used as a spreader and sulphanilamide added to keep down the growth of fungi. The percentage of reversals to the pistillate condition was slightly less than that of the corresponding set not receiving sucrose, but there was a considerable increase in racemeless individuals.

Tampering with the nutrition of Ambrosia plants in the early vegetative stage seldom leads to a sex reversal. This is borne out by the present work and by previous reports of negative results when mineral nutrients were added to the soil (Jones, 1936) and when plants from ten to twenty days old were exposed to short days (Jones, 1947).

Once floral primordia are initiated, several external agents of unlike nature bring about an alteration from staminate to pistillate structures. Short-day treatment is particularly effective, but defoliation and the application of chemicals to the stem apex may give results. I have had some positive results by using indole acetic, phenylacetic, and α estradiol propionate (Pl. II, Figs. 1–2). The change from the pistillate condition of the lateral flowers to the staminate is rare, but two instances were noted (Jones, 1947).

The fact that defoliation alone is sufficient to produce sex reversal is a vexation to the experimenter studying the effects of photoperiodism. If he takes a two-branched foliated plant and gives one branch short-day exposures, the treated branch will usually form some pistils in its raceme, whereas the branch receiving the normal photoperiod of late summer will be staminate. If the untreated branch is defoliated, it will very likely become pistillate, but it is impossible to ascertain whether this reversal in a given specimen is the result of defoliation or of a transfer of some stimulus from the short-day branch.

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PLATES I–II

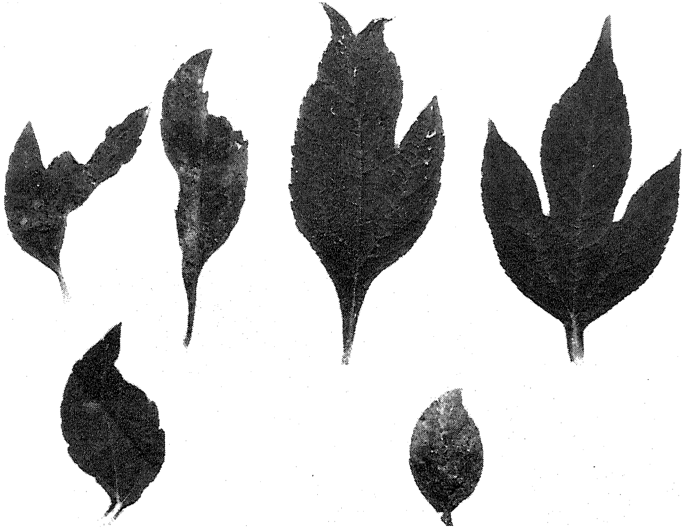

FIG. 1. Malformed leaves of *A. trifida* pistillate plants. The parent plants underwent sex reversal from short-day treatments

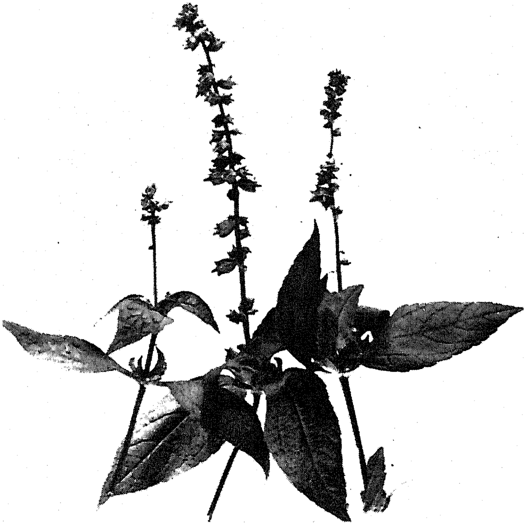

FIG. 2. Pistillate racemes of *A. trifida* from plants from which the cotyledons had been removed

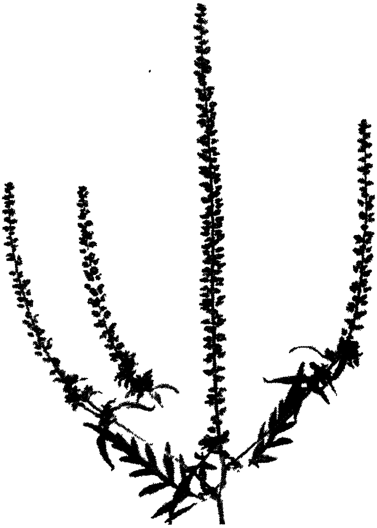

FIG. 1. Branch of *A. elatior* bearing staminate racemes (control)

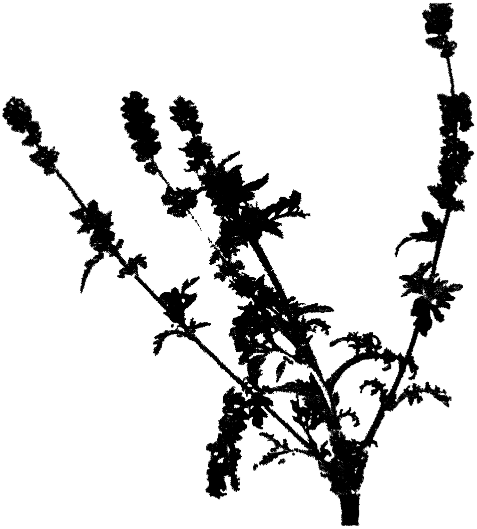

FIG. 2. Branch of *A. elatior* on the same plant and opposite to the one shown in Figure 1. This cluster of four racemes, three of which show some pistillate structures, developed from a stem apex to which α estradiol propionate had been applied

SOME ECOLOGICAL ASPECTS OF THE ACRASIALES IN AND NEAR MADISON, WISCONSIN

EUGENE D. KITZKE

INTRODUCTION

IN THE Myxomycetes there is a relatively small group known as Acrasiales. They are strikingly different from true Myxomycetes in that the individual myxamoebae retain their plasma membranes, keep their individuality, and form a pseudoplasmodial stage. The plasmodial stage of the true Myxomycete differs, of course, in that it has no individual cells and is a naked mass of multinucleated cytoplasm.

Since the group as now known is a small one, a concise study of its distribution in a limited area can be made in a summer's work. Sixty soil samples from various localities within a twenty-five mile radius of Madison were tested. In addition, an attempt was made to find significant correlations between certain measurable factors of the soil and the presence of the organisms. The soil factors of pH, the percentage of organic matter, and the colloid percentage were determined for each sample. The plant associations of each soil source were also considered as variable factors.

MATERIALS AND METHODS

Of sixty soil samples thirty-six yielded members of the Acrasiales. From these, four species were identified. Two belonged to the genus *Dictyostelium* and two to *Polysphondylium*.

Representative field samples of grassland, marshland, sand dunes, shrub areas, and humus from various stands of hardwood forests were collected in sterile 60 c.c. bottles. They were taken to the laboratory, where they were processed almost immediately by various soil-analysis procedures (to be described later).

METHOD OF ISOLATION

The soil sample was poured out on a fresh paper towel, and particles or crumbs of it selected at random were placed on petri dishes of soil agar (Singh, 1946). Ten plates were prepared from each sample in order to permit a calculation of the distribution frequency percentage for the organisms. Incubation was carried out at room temperature (summer temperatures ranging from 22° to 26° Centigrade) for four days, after which the plates were examined for fruiting structures of the fungus.

Plates containing the fruiting structures of the Acrasiales were set aside an extra day for further development to permit heavier growth. The next day the remaining plates, hitherto blank, were reëxamined to determine whether any slower-growing forms had appeared, a thing that rarely happens. Plates bearing the desired organisms were then transferred by inoculation of terminal sorus spores to petri plates of mannite agar (*Difco Manual,* 1937) already supporting a streak growth of *Escherichia coli.*

The bacterial population of the streak afforded abundant food for the Acrasiales, and they attained luxuriant growth in this mixed culture. Often the transfer from soil agar carried along with it contaminants, the growth of which was eliminated by a second transfer. The organism, when finally isolated into a "pure-mixed"[1] culture (Raper, 1937), was transferred to a mannite agar slant for stock culturing and identification. Since the Acrasiales require bacteria for food, they must be kept in such a culture.

Because soil is a rich source of a great variety of fungi, the medium originally used to isolate the Acrasiales had to be one that could limit the number of contaminants. Experience with mannite agar has shown that heavy growth of unwanted forms of fungi occur on the plates and may obscure the more delicate Acrasiales. This could be obviated if precautions were taken to incubate the plates at 15° to 16° Centigrade for a two-week period; but this technique was impracticable in the present study because of summer temperatures and lack of incubator space.

The use of soil agar as the initial isolating medium greatly expedited matters, for Acrasiales, if present, appeared after four days' incubation at room temperature. The low nutrient value in this medium prevented the normal overgrowth that occurred in the comparatively rich mannite agar. The soil-extract agar was prepared after Hesseltine (paper in preparation). Its composition was as follows:

[1] The term "pure-mixed" as applied to a culture refers to the growth of some suitable bacterium and a member of the Acrasiales, each in pure culture, in the same dish or tube.

Agar agar	15 gm.
K_2HPO_4	0.5 gm.
Glucose	1 gm.
Soil extract[2] ...	100 c.c.
Tap water	900 c.c.

The original purpose for which this medium was designed was to isolate and culture mucors without getting a heavy overgrowth of contaminants or of the mucors themselves. Hesseltine noticed that it also lent itself rather consistently to supporting the growth of members of the Acrasiales. Thus it was adopted by the writer.

TECHNIQUE OF SOIL ANALYSIS

The soil samples were processed immediately after collection. The pH was determined by means of a Beckman pH meter. The approximate percentages of organic matter in them were ascertained by the use of the ash technique of Schollenberger (1931). When the margin of error due to carbonates and other compounds that may have been oxidized has been taken into consideration, the values obtained may be considered approximations.

The colloidal percentage was determined for each sample by the use of the Cenco-Wilde[3] test, known as the hydrometer field test.

ORGANISMS ISOLATED

Four species belonging to two genera were isolated. Two, *Dictyostelium mucoroides* and *Polysphondylium violaceum,* occurred very commonly. In a small number of plates *Polysphondylium pallidum* appeared, a not uncommon species, according to Raper (1940), and *Dictyostelium minutum,* which is perhaps rare, since it has been reported infrequently in the literature.

Polysphondylium violaceum

P. violaceum has been described in an earlier paper by Kitzke (1950).

Dictyostelium mucoroides Brefeld

The measurements of the spores of *D. mucoroides* Brefeld, 3–5 × 5–8 μ, are somewhat larger than those given by Olive (1902); he does state, however, that the range is great. The diameters of the sori range from 100 to 600 μ, which agrees with Olive's measurements. The heights of the sorocarp differ greatly, ranging in many from 5 mm. in some to well over 1 cm.

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[2] The soil extract was prepared by heating one kilogram of soil with one liter of tap water in an Arnold sterilizer for one hour, after which it was filtered two or more times until clear and then autoclaved for one hour on two successive days.

[3] Cenco-Wilde Soil Colloid Tester No. 28250.

Dictyostelium minutum Raper

The spores of *D. minutum* measured 3–3.5 × 5–7 μ. An extensive study of their sizes revealed none outside this range, which is identical with that given by Raper (1941). The heights of the sorocarp ranged from 350 to 750 μ. The sori exceeded very little the largest diameter in the range (75 to 150 μ) listed by Raper. In spite of the ample food supply and the frequent transfers the growth of the organism was consistently small, which indicates that the species is different from any described, except *minutum*.

Polysphondylium pallidum

P. pallidum, described by Raper (1940) as of common occurrence, was found only infrequently in our samples. The measurements of the isolate, which correspond closely with those listed by Olive, are as follows: spores, 3.5–4 × 7–8 μ; terminal sori, 50–90 μ in diameter; lateral sori, 30–40 μ in diameter; sorocarp, 300–400 μ tall.

CORRELATIONS

The sites of collection, all within a twenty-five-mile radius of Madison, are listed in Table I.

TABLE I

SOURCES OF THE SOIL SAMPLES

Site	*Location*
Grady tract	University Arboretum
Stewart's woods	Dane County
Bascom woods	University campus
Wollein's woods	Jefferson county
Willow drive	University campus
Grasslands	Forest Products Laboratory Road
Pine barrens	Arena
Prairie	Lake Mills

The pH values of the soils tested were within a narrow range and afforded little variation to enable me to detect growth patterns. When,

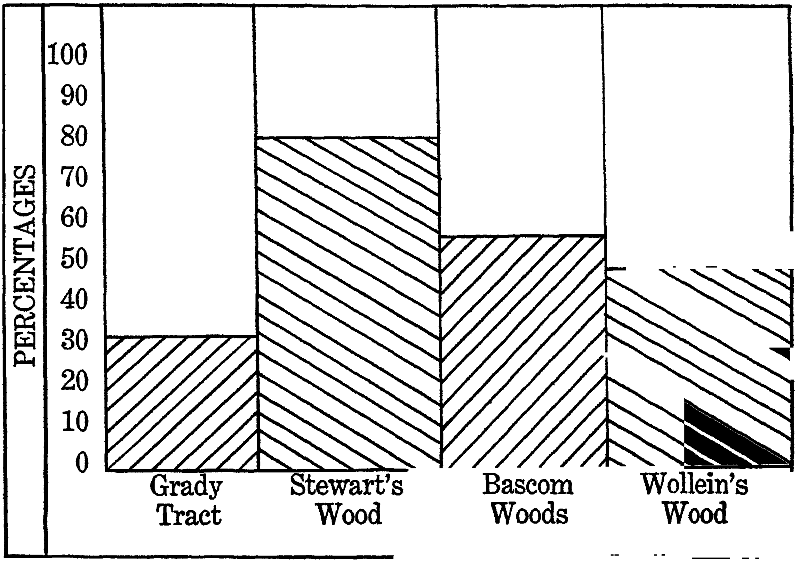

FIG. 1. Frequency percentage of Acrasiales in four quadrats

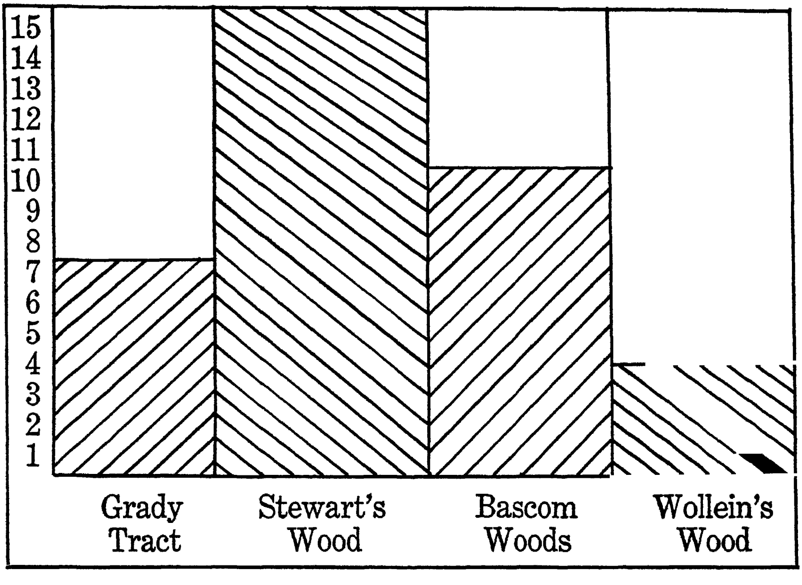

FIG. 2. Number of shrub species

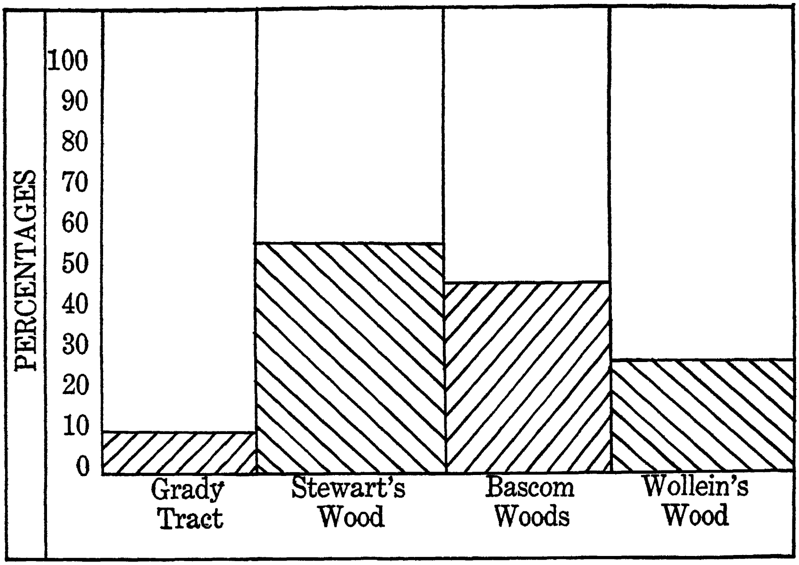

FIG. 3. Frequency percentages of herb species in four oak quadrats

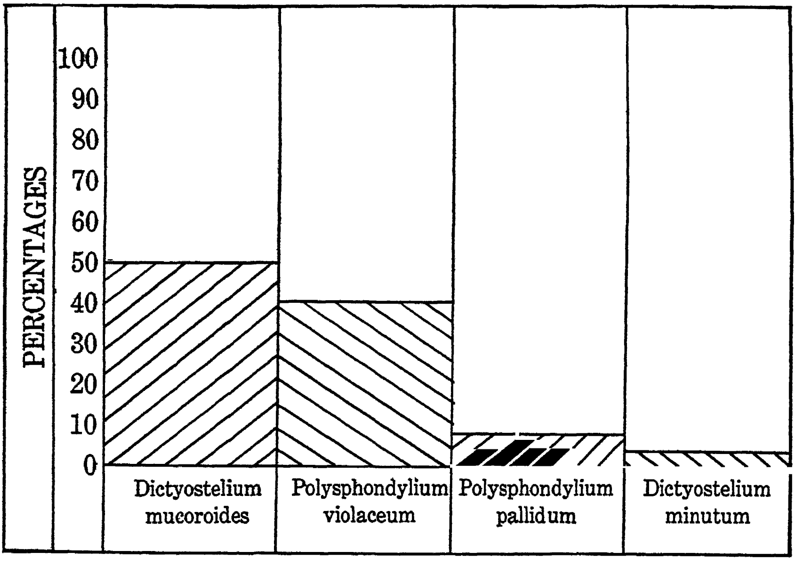

FIG. 4. Relative percentages of Acrasiales isolated

however, a large number of pH values below 6 were found, which, according to Raper (1939), is definitely not optimum, there was less growth of Acrasiales.

Soil colloid percentages and minimum organic percentages do not seem to have any obvious correlation with the presence of the organisms. In general, however, with the increase in the percentage of organic matter there is an increase in the frequency percentage of Acrasiales.

Figure 1 shows the frequency percentages of Acrasiales in the four quadrats which were studied thoroughly from an ecological viewpoint. Stewart's woods has the highest frequency percentage of Acrasiales and also the heaviest occurrence of herbs and shrubs. In fact, the graphs showing the data for the herb and shrub species (Figs. 2–3) closely resemble those for the occurrence of Acrasiales in these quadrats. This may be due to the greater number of bacteria decomposing the herb and shrub litter, which accumulates more rapidly in Stewart's woods than in Bascom woods, the Grady tract, or Wollein's woods. Thus an increase in the number of bacteria provides a greater food supply for the Acrasiales, and hence enables them to attain more uniform distribution.

Of the sixty samples taken and tested 60 per cent contained members of the Acrasiales. Only 40 per cent showed a complete absence of them or failure of the organisms to develop from them when inoculated with soil. The percentages of the different species found in the successful plates are given in Figure 4.

The total number of isolations was 157, composed of the following species: *Dictyostelium mucoroides,* 76; *Polysphondylium violaceum,* 60; *P. pallidum,* 12; and *D. minutum,* 9. These figures seem to be indicative of their relative distribution in the soils tested and confirm in general the reports of other workers (Raper, 1940; Olive, 1902).

SUMMARY

Members of the Acrasiales were isolated from soil samples taken at random within a twenty-five-mile radius of Madison, Wisconsin. The experiments show that soil agar provides an excellent isolating medium and that mannite agar used in connection with "pure-mixed" cultures is a good medium for stock culturing. The Acrasiales occurred in 60 per cent of the sixty soil samples tested.

No correlations for colloidal percentages were noted. With respect to the percentage of organic matter of the soil samples there was found to be an increase of Acrasiales, with an increase of organic material in the soil.

The factor of pH does not seem to affect the frequency of occurrence of Acrasiales, mainly because of great variability in soil types. There seems to be a lower frequency percentage of Acrasiales, however, in plates inoculated from soils near pH 5 and 8.

Four species of Acrasiales were isolated representing two genera. Three species, *D. mucoroides, P. violaceum,* and *P. pallidum,* were reported common by other workers. One, *D. minutum,* first isolated by Raper (1941), appears to be relatively rare. *P. pallidum* also occurs only infrequently in this study.

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THE EFFECT OF HORMONE ON BARK RENEWAL IN *HEVEA BRASILIENSIS* *

THOMAS J. MUZIK

BARK renewal of *Hevea brasiliensis* Muell. Arg., the Pará rubber tree, after tapping has been the subject of considerable investigation. It has been reported that various substances increase the rate of renewal. Beeley and Baptist (2) found that palm oil improved it from 25 to 50 per cent over a three-month period, although, strangely enough, Baptist (1) obtained no increase one year after applying indolyl-acetic acid, and he ascribed this lack of effect to the weak concentrations used, 1 : 1,000, 1 : 5,000, and 1 : 10,000 in lanolin. Other workers have reported that a number of substances are more or less effective, namely, mineral oil (2), coal tar (9), cow dung and clay mixture (1), tar (10), a solution of MgCl and NaCl in water, and distilled water alone (6). Sharp (8) noted that healing of large stumps was promoted by treatment with cow dung and Hessian cloth, whereas linseed oil and zinc oxide had no effect, and an asphalt-kerosene mixture retarded healing. Gandrup (4) claimed that tar had no effect on bark renewal.

Since many of these substances probably contain hormones and since the results reported above conflict, the author undertook the experiments here described.

MATERIALS AND METHODS

These experiments were carried out on the Firestone Plantations in Liberia, West Africa, from December, 1945, to March, 1946, the "dry season" in that part of the tropics. The clone Avros 152 was chosen because the bark is reasonably free from knots or ridges, and natural renewal is relatively slow. Only the lower half of each panel was treated; the upper half served as the control (Pl. I). Thus each tree was used for both treatment and control, and the relative growth rates of treated and untreated zones of the same panel could be measured. This method eliminated variation due to different growth rates of trees, a factor which may well have influenced the results reported above. As La Rue (7) has pointed out, the rate of renewal is affected greatly by many environmental conditions, such as soil and the tapping system, as well as hereditary factors.

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* Papers from the Department of Botany, University of Michigan, No. 895.

This work was done while the author was a member of the Research Department of the Firestone Plantations Company, Harbel, Liberia. It is published with the permission of the Company.

Two hormones were tested, both in lanolin, indole-3-acetic acid in concentrations of 1:1,000, 1:5,000, and 1:10,000, and indole-butyric acid in concentrations of 1:1,000, 1:5,000, and 1:10,000. The effect of pure lanolin was also tested. Five trees were treated with each concentration of hormone daily, immediately after tapping. The hormones were applied in the same manner as panel fungicides, that is, with a small brush and directly on the bark tapped on the same day. Bark thickness was measured at monthly intervals, by means of a standard bark gauge. An average of three measurements was taken at each reading, although the variation in thickness was considerably less in this clone than that reported by Haigh (5) for certain seedling trees.

These trees were planted as seedling stumps in 1928 and grafted in 1933, when four to five years old. They were first tapped in 1939 on a half-spiral system, then placed on a full spiral from July, 1942, to March, 1943, and returned to the half spiral in March, 1943. The panel was about twenty inches from the graft union, and the average girth at sixty-five inches above the union was 61.7 cm. The tapping cut was at an angle of 30° from left to right and was made from the upper side down toward the cup (Pl. I). An especially good worker was assigned to these trees to insure even tapping. The bark was removed to a depth of one millimeter from the cambium. The trees were tapped on alternate days, and one fifteenth of an inch[1] of bark was excised at each operation. Frequent inspections of the trees were made.

EXPERIMENTS WITH INDOLE–3–ACETIC ACID

Indole–3–acetic acid was used in the first treatments. It was applied daily in concentrations of 1:1,000, 1:5,000, and 1:10,000 in lanolin. Bark thickness was measured at monthly intervals for three months after treatment. The initial thickness was one millimeter. The depth of renewed bark after treatment is shown in Table I.

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[1] Note the two systems of measuring; the depth of tapping is invariably measured in the metric system and the amount of bark removed, in the English system.

TABLE I

THE EFFECT OF INDOLE-3-ACETIC ACID ON BARK RENEWAL

In all these experiments the lower half of the panel was treated and the upper half served as a control.

Tree	Bark thickness in millimeters		
	First month	Second month	Third month
LINE A. Concentration 1 : 1,000			
1 Treated	7.2	7.8	7.8
Control	6.7	6.8	7.0
2 Treated	8.3	9.2	9.3
Control	6.2	6.3	7.2
3 Treated	8.3	9.6	11.0
Control	5.7	6.9	8.5
4 Treated	8.7	9.9	10.5
Control	6.5	7.0	7.8
5 Wind-damaged	..	..	..
Average:			
Treated	8.13	9.13	9.65
Control	6.28	6.75	7.63
Difference	1.85	2.38	2.02
Increase	29.5%	35.3%	26.5%
LINE B. Concentration 1 : 5,000			
1 Treated	7.5	9.5	9.6
Control	7.7	7.8	8.0
2 Treated	8.1	9.1	9.2
Control	4.8	6.0	6.4
3 Treated	9.5	10.8	10.8
Control	6.1	8.5	8.7
4 Treated	7.3	7.4	9.0
Control	5.5	5.9	6.2
5 Treated	6.1	7.1	7.3
Control	6.1	6.5	7.2
Average:			
Treated	7.70	8.78	9.18
Control	6.04	6.94	7.30
Difference	1.66	1.84	1.88
Increase	27.5%	26.5%	25.8%
LINE C. Concentration 1 : 10,000			
1 Treated	7.2	10.0	10.3
Control	6.0	7.7	8.0
2 Treated	6.9	7.0	7.5
Control	5.1	6.1	6.3
3 Treated	7.7	9.0	9.2
Control	6.7	7.1	7.5
4 Treated	8.0	8.1	8.6
Control	5.7	6.2	6.8
5 Treated	6.9	8.0	8.6
Control	5.0	5.2	5.4
Average:			
Treated	7.34	8.42	8.84
Control	5.70	6.46	6.80
Difference	1.64	1.96	2.04
Increase	28.8%	30.3%	30.0%

These experiments were not continued for more than three months because abundant production of stone cells in the bark made accurate measurements very difficult. Later measurements indicate, however, that the treated portion of the panel maintains its greater thickness for at least five months after treatment.

The increase in bark thickness due to the hormone application was

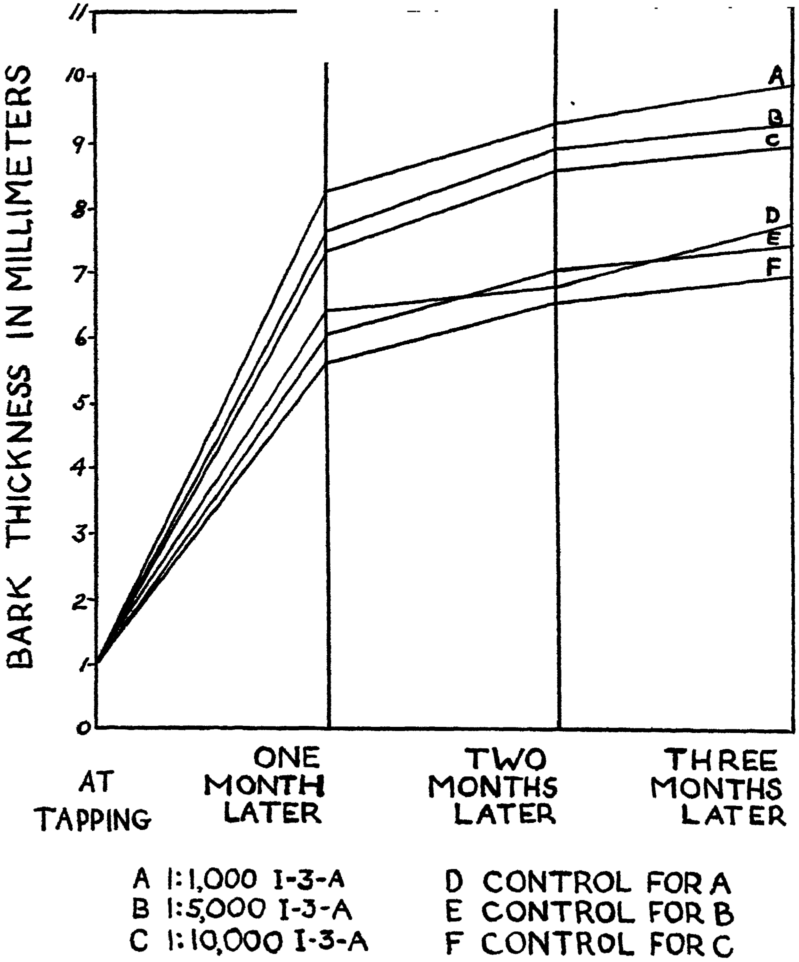

FIG. 1. Bark renewal in Avros 152 over a three-month period. A separate control is measured for each treatment (see text)

clearly visible as a swelling on the treated zone of the panel. A striking feature of this experiment was the greater quantity of latex exuding from the treated zone than from the untreated zone, possibly indicating a better developed latex system. As Bobilioff (3) has shown, formation of new latex vessels takes place very soon in renewing bark. However, definite proof that more vessels are formed in the treated zone must await histological examination.

The most rapid renewal of bark occurs in the first month after tapping; it tapers off in the second and third months. Figure 1 shows the relative rates of renewal over the three-month period. The 1 : 1,000 concentration exhibited the greatest effect, giving an increase over the control of 29.5 per cent in the first month, which rose to 35.3 per cent in the second month. In the third month the increase was only 26.5 per cent. The other concentrations proved to be somewhat less effective. The 1 : 5,000 solution was least effective.

EXPERIMENTS WITH LANOLIN AND INDOLE-BUTYRIC ACID

A second series of experiments was devised to determine how much of the increase noted in the previous one was due to hormone stimulation

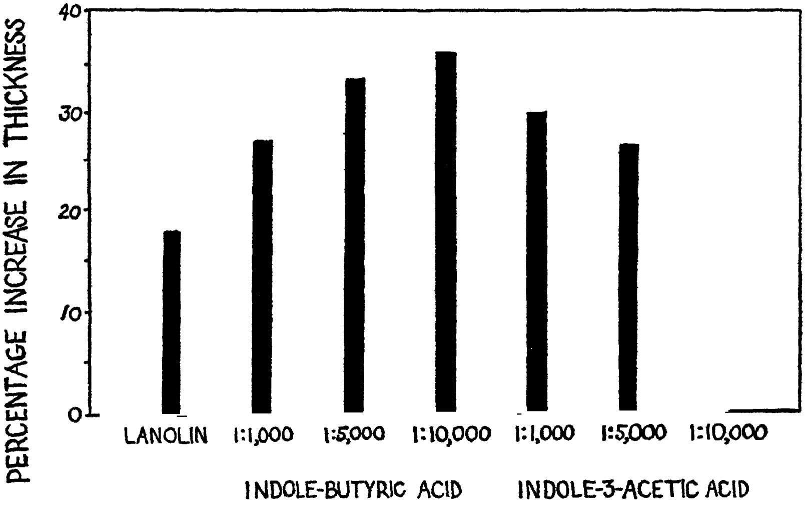

FIG. 2. Percentage increase of treated portion of panel over untreated (100 per cent) one month after treatment

and how much to the effect of the lanolin carrier in preventing desiccation. It was carried on for one month.

TABLE II

THE EFFECT OF LANOLIN AND INDOLE-BUTYRIC ACID ON BARK RENEWAL

In all these experiments the lower half of the panel was treated and the upper half served as a control. The figures give the bark thickness one month after treatment.

LINE D		LINE E	
Lanolin		1 : 5,000 indole-butyric	
Tree	*Mm.*	*Tree*	*Mm.*
1 Treated	6.7	1 Treated	7.2
Control	5.2	Control	5.3
2 Treated	8.2	2 Treated	8.1
Control	6.8	Control	6.4
3 Treated	5.8	3 Wind-damaged	
Control	4.8		
4 Treated	6.6	4 Treated	6.7
Control	6.0	Control	5.6
5 Treated	6.4	5 Treated	7.3
Control	6.0	Control	4.7
Average		Average	
Treated	6.74	Treated	7.33
Control	5.76	Control	5.50
Difference	0.98	Difference	1.83
Increase	17.0%	Increase	33.3%

LINE F		LINE G	
1 : 1,000 indole-butyric		1 : 10,000 indole-butyric	
Tree	*Mm.*	*Tree*	*Mm.*
1 Treated	8.1	1 Treated	7.4
Control	6.8	Control	4.7
2 Treated	7.3	2 Treated	9.1
Control	6.4	Control	7.3
3 Treated	7.6	3 Treated	7.1
Control	5.2	Control	5.4
4 Treated	8.6	4 Treated	7.4
Control	6.2	Control	5.4
5 Treated	6.7	5 Treated	7.7
Control	5.4	Control	5.8
Average		Average	
Treated	7.66	Treated	7.74
Control	6.00	Control	5.72
Difference	1.66	Difference	2.02
Increase	27.7%	Increase	35.3%

Pure lanolin and solutions of 1 : 1,000, 1 : 5,000, and 1 : 10,000 parts indole-butyric acid in lanolin were applied to the same clone, under the experimental conditions previously stated. The initial thickness of bark was one millimeter. The depth of renewed bark one month after treatment is shown in Table II.

Although lanolin alone increases the rate of renewal by 17.0 per cent, there is an additional stimulation due to the presence of the indole-butyric acid. This hormone is most effective at a concentration of 1 : 10,000, which gives an increase of 35.3 per cent or 2.02 millimeters one month after treatment. The relative percentage increment over the control is shown in Figure 2. The first-month increase in the previous experiment, which was due to the indole-3-acetic acid, is also shown for the sake of comparison.

DISCUSSION

Although the stimulating effect of indole-butyric acid becomes more marked as concentration decreases, this is not true of indole-3-acetic acid. Here the 1 : 1,000 concentration is most effective, at least in the early stages, and the 1 : 5,000 concentration shows the least effectiveness.

The effect of the lanolin is probably due to the fact that it protects the bark from desiccation, particularly during the dry season. Possibly this effect would not be so marked during the wet season.

SUMMARY

1. Experiments dealing with the effect of indole-3-acetic acid, indole-butyric acid, and lanolin on bark renewal are described.
2. The rate of renewal is most rapid in the first month after tapping.
3. Both the indole-3-acetic acid and the indole-butyric acid stimulated the rate of renewal.
4. Lanolin alone increased the renewal 17 per cent in the first month after application.
5. The treated zone of the panel exuded more latex when pierced by the bark gauge than did the untreated zone.
6. Indole-3-acetic acid is more effective at the highest concentrations used than at the lower concentrations, at least in the early stages.
7. Indole-butyric acid is most effective at the lowest concentrations used.

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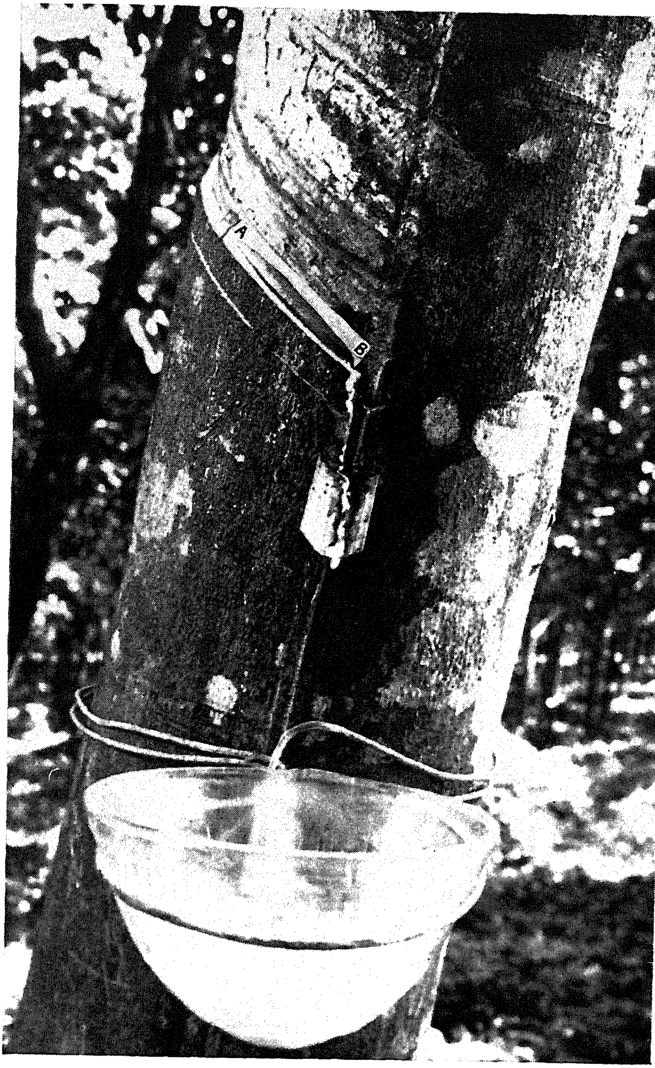

The trunk of a rubber tree (Hevea), showing tapping panel, spout, and glass cup full of latex. Area of panel between *A* and *B* treated with hormone. Upper side of panel, beyond *A*, untreated

FORESTRY

SOME RESUPINATE POLYPORES FROM THE REGION OF THE GREAT LAKES. XXI*

DOW V. BAXTER

IN 1922 the author began a survey of North American polypores. Since that time he has made field studies in every state of the Union, in Alaska, in every Canadian province as well as in the Yukon Territory, the Northwest Territories, and also in Labrador and Newfoundland (both of which have recently been annexed to Canada). In all reports of investigations and field expeditions (1) the title has been kept the same to preserve their unity and to facilitate references. It is the author's plan to incorporate in a volume on the resupinate polypores of North America the results of all these studies and to include additional data gathered since the publication of the various articles.

The present paper contains five reports on resupinate forms or pileate forms that have become resupinate.

The color terms given within quotation marks are those of R. Ridgway, *Color Standards and Color Nomenclature* (Washington, 1912).

Polyporus distortus (Schw.) Fr.

Abortiporus distortus (Schw.) Murr., Bull. Torr. Bot. Club, 31 : 422. 1904.
Boletus distortus Schw., Syn. Fung. Car., 71. 1818.
Polyporus abortivus Pk., Bot. Gaz., 6 : 274. 1881.

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Polyporus rufescens (Pers.) Fr. ex Lloyd, but held distinct by Murrill, Bull. Torr. Bot. Club, 31 : 422. 1904.

Fructification variable in growth habit, intertwined with roots and sticks or with central or lateral stem; stem often deeply extended and frequently tubercular to sclerotoid, extension which intertwines with decayed roots or wood, 8–12 cm. or more below the ground; pileus when developed 1–6 mm. thick, minutely but densely villose, "vinaceous buff"; context fibrous-tough, concolorous, duplex — the upper layer thin, the remaining radially fibrous; tubes 1–5 mm. long; mouths 0.5–3 to a mm.; spores[1] smooth, apiculate, ellipsoid to ovoid, 5–6 × 3.5–4 μ, chlamydospores 5–7 μ in diameter sometimes present, cystidia present or none, scarcely projecting beyond the hymenium; hyphae seldom branched, 4–8 μ in diameter.

Allied species. — The plant is described among the resupinate polypores since it may occur in a resupinate state about upright sticks. It suggests, for example, *Poria ambigua,* which at times may exhibit such a habit of growth. The pore mouths are similar in size, and the measurements of the spores for the two species overlap. There is no duplex context in *P. ambigua,* and the poria dries crisp and becomes so fragile that it is readily reduced to a powder between the fingers. *Pol. distortus* becomes harder upon drying.

As might be inferred from the similarity of names, resupinate forms of *Polyporus distortus,* which is especially variable in nature, may be mistaken for *Poria distorta* Murr. The tubes of *P. distorta* are given as shorter, being 1–2 to a mm. instead of 1–5 mm. long. Their mouths, too, are smaller. In *P. distorta* they are 4–5 to a mm., whereas in *Pol. distortus* the mouths are 1–3 to a mm.

Habitat. — *Acer Negundo, A. rubrum, A. saccharum, Ailanthus glandulosa, Betula nigra, B. papyrifera, Carya alba, C. illinoensis, Fraxinus sp., Juglans cinerea, J. nigra, Liriodendron Tulipifera, Magnolia grandifolia, Malus pumila, Plantanus occidentalis, Quercus alba, Q. palustris, Salix sp., Tilia americana, T. glabra.*

Distribution. — British Columbia, Ontario; Alabama, Arkansas, Connecticut, Delaware, District of Columbia, Florida, Illinois, Indiana, Iowa, Kentucky, Louisiana, Maryland, Massachusetts, Michigan, Missouri, Montana, New Jersey, New York, North Carolina, Ohio,

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[1] Kauffman noted that in immature specimens or arrested-growth forms the pileus is a mass of pores filled with spores. Portions, at least, produce numerous conidia borne singly on slender sterigmata where present. The conidia are subglobose, and are about 10 μ in diameter.

Oregon, Pennsylvania, Tennessee, Texas, Virginia, Washington, Wisconsin.

Occurrence. — This plant may not always be wood-inhabiting, for it grows frequently about stumps and trunks of deciduous trees in low wet places. Kauffman found it around poison ivy roots and noted it in basswood and maple woods.

Cultures. — Isolated by Davidson, Campbell, Blaisdell (5). The fungus causes a positive reaction to tannic acid medium.

Trametes mollis (Sommf.) Fr., El. 71. 1828; Hymen. Eur. 585. 1874

Antrodia mollis (Sommf.) Karst. in Medd. Soc. pro Fauna et Flora Fenn., 5 : 40. 1879.

Daedalea mollis (Sommf.), Suppl. Fl. Lapp., p. 271. 1826.

Polyporus cervinus Pers., Myc. Eur., 2 : 87. 1825 (non *Trametes cervina* (Schw.) Bres., 1903.)

Polyporus mollis (Schw.) Kroh et Almqu., Svensk. Fl., 2nd edition, 5 : 274. 1932 (teste Pilát, 1936) (non *P. mollis* Fr., 1 : 360. 1821; nec Persoon, Myc. Eur., 2 : 62. 1825).

Trametes cervina (Pers.) Lloyd, non *Boletus cervinus* Schweinitz, Schriften Nat. Gesell., Leipzig, 1 : 96. 1822. (*P. cervinus* Fries, Epicr., 474. 1838; *Trametes cervinus* Bres., Ann. Myc., 1 : 81. 1903.)

Trametes stereoides (Fr.) sensu Bres. in Atti Ac. Agiati, III, 3 : 92. 1897. Shope in Ann. Mo. Bot. Gard., 18 : 367. 1921 (non *Polyporus stereoides* Fr., 1831).

Important specimen:

Trametes mollis Sommf., East Berne, Adirondack Mts. Leg. C. H. Peck (*Pol. cervinus* Pers.). Herb. N. Y. State Museum.

Fructification coriaceous, sessile, but more often effused-reflexed or resupinate, reflexed part conchate, 0–2 × 1–9 × 0.1–0.3 cm.; surface tomentose, zonate, brown, "Saccardo's umber" to "sepia"; margin thin, concolorous, becoming revolute; context 1 mm. or less in thickness, "cinnamon buff"; tubes up to 4 mm. long, concolorous with the context; mouths variable in shape, poroid, often becoming sinuous or daedaloid, 1–2 to a mm., "pinkish buff," "cinnamon buff" to "Saccardo's umber," spores hyaline, smooth, cylindric, 9–12 × 3.5–4.5 (Shope).

Allied species. — *Trametes mollis* (Sommf.) Fr. resembles *Trametes variiformis* closely. I suspect that, if specimens of *T. variiformis* were found in Europe, they might receive the name *T. mollis,* just as some coniferous collections have been so labeled in this country. The spores of the hardwood-inhabiting *T. mollis* (Sommf.) Fr. (7–10 × 2.5–3.5 μ) are about the same as those of the coniferous fungus *T.*

variiformis (6–8 × 2.5–3 µ). The tubes of *T. variiformis* are generally longer, but this character is only relative. The context of *T. variiformis* is duplex, the upper layer being concolorous with the surface, whereas in *T. mollis* the context is pale brown or clay color.

T. campestris Quél. is also closely allied, since it may resemble *T. mollis* in general appearance. The spores of *T. campestris,* however, are large (10–15 × 4.5–5.5 µ Pilát).

Romell (16) discusses a specimen of *Pol. stereoides* with pore mouths 4–5 to a mm. (Lapland). Its habit resembles that of a Stereum. The plant agrees with an authentic specimen from Femsjö in the herbarium of Fries. It is believed that Elias Fries either "suggested the name or at least approved it." Romell adds: "There is, however, another authentic specimen (with a label written by El. Fries), but this belongs to *Pol. cervinus* Pers." For the record Romell keeps this *Pol. cervinus* (*Daedalea mollis* Sommf., *Trametes mollis* Fr.) separate. According to him, it is "a species which is really closely allied, though in my opinion specifically distinct, *as it is much thicker and has pores more than twice as large and consequently a different habit,* and no intermediate connecting forms exist." *Pol. stereoides* is regarded as a northern plant and one never seen by Romell but in Lapland.

Difficulty has also been created by calling other and unrelated plants "mollis." Among these are certain more fragile polypores which are slightly red or which become reddish upon bruising or drying. *Pol. mollis,* for example, a soft, watery species when fresh, becomes rigid and red or pink when dry (17). It is an entirely different plant from *T. mollis.*

Irpex mollis should not be mistaken for *Trametes mollis. I. mollis* B. & C. is characterized by long (1 cm. or more) white teeth. The entire pileus is large and thick, remaining white or cream color in contrast to the browns exhibited by *T. mollis* (Sommf.) Fr.

Habitat. — *Acer circinatum, A. pennsylvanicum, A. saccharinum, A. saccharum, A. spicatum, Alnus rubra, Betula lutea, B. papyrifera, B. papyrifera kenaica, Fagus grandifolia, Fraxinus americana, Ostrya virginiana, Picea Engelmanii, Pinus Strobus, Populus balsamifera, Quercus alba, Q. Garryana, Q. phellos, Salix sp., Sambucus cœrulea, Ulmus americana.*

Distribution. — Alaska, Northwest Territories; British Columbia, Labrador, Nova Scotia, Ontario, Quebec; Arizona, California, Colorado, Idaho, Illinois, Kentucky, Maine, Michigan, Montana, New Hampshire, New Jersey, New York, North Carolina, Ohio, Oregon, Pennsylvania, Rhode Island, Tennessee, Texas, Vermont, Washington, West Virginia.

Cultures. — Isolated by Davidson, Campbell, and Blaisdell (5), who report that the fungus gives a strong positive reaction to tannic acid medium.

Poria subserpens Murr., Lloydia, 10 : 245–246. 1947

(Plates I–III)

Trametes subserpens Murr., Mycologia, 12 : 107–108. 1920.

Trametes serpens Auct. Am., but Lloyd only pro parte (some determinations made by Lloyd are *Poria papyracea,* and not *Trametes subserpens*).

Elmeriana setulosa (P. Henn.) Bres., Philippines (?), teste Murr., Mycologia, 12 : 108. 1920.

Poria setulosa P. Henn. (?), teste Murr., Lloydia, 10 : 246. 1947.

Type and important specimen observed:

Trametes serpens Fr., "orig. ex." Fries. Femsjö, Sweden. Herb. of Bresadola, Stockholm.

Fructification white, pallid, or cream, corky, appearing in patches frequently about 4 × 3 cm., but becoming widely effused for as much as one or two meters, sometimes curled at margin but mostly resupinate, averaging 1 mm. in thickness; margin up to 1 mm. wide, "light buff"; tubes often arranged obliquely, 1–2 mm. long; hyphal pegs in tubes visible under hand lens (Overh.); mouths 1–2, mostly 2, to a mm., concolorous with the margin; dissepiments thick; spores 8–10 × 3.5–4.5 μ; hyphae 2–2.5 (3) μ in diameter.

Allied species. — *Poria subserpens* is one of the most distinctive of the resupinate polypores of the Gulf states. There has been some confusion about the name that should be applied, but no closely related species exist in continental North America. The name *P. straminea* Bres., designating a plant of the Philippines, has been variously interpreted, and some of the versions have been so broad as to include *P. subserpens.* Likewise, *P. setulosa* P. Henn. of the Philippines resembles *P. subserpens.*

Poria subserpens and *Trametes sepium* may be confused since both are coriaceous; they may resemble each other in color and in size of pore mouths. The dissepiments between the mouths are thick in both, and the two polypores are frequently entirely resupinate. The spores of *P. subserpens* are 8–10 × 3.5–4.5 μ, and those of *T. sepium* are 8–14 × 3.5 μ.

Poria subserpens is apt to be whiter than *Trametes sepium.* Furthermore, the relatively thin margin of *P. subserpens* is more likely to become upturned upon drying, with the tube layer remaining definitely resupinate. Drying affects *T. sepium* but little, and the margin in fresh plants becomes more effused-reflexed or even pileate in form, the pilei being often nodulose. A nodulose appearance is never evident in *P. subserpens.*

The two species, however, may be readily distinguished in culture by the fact that buff-colored pores are formed by *Trametes sepium* on both hardwood and coniferous blocks in one-year-old tests, whereas no pore formation takes place on either red gum or white pine in cultures of *Poria subserpens.*

Specimens of *Trametes serialis* may be mistaken for those of *Poria subserpens.* In nature *T. serialis* is chiefly a conifer-inhabiting fungus, whereas *P. subserpens* occurs on hardwoods.

Since resupinate specimens of *Fomes fraxinophilus* are corky, white or whitish, and possess a white to light-brown context, and since the mouths of the tubes average 2–3 to a mm., some difficulty may be encountered in separating it from *Trametes subserpens. F. fraxinophilus* grows on standing trunks, whereas *T. subserpens* is mostly, if not always, on logs. The spores of *F. fraxinophilus* are ellipsoid to ovoid, measure 6–8 × 5–6 μ (Lowe), and are not cylindric-ellipsoid, as in the species of Trametes discussed.

Some specimens of *Poria subserpens* might suggest those of *Trametes mollis* (Sommf.) Fr., which is never as white as most specimens (and all freshly growing plants) of *P. subserpens.* The margins of the two species are characteristic. At least, *T. mollis* is more often effused-reflexed, the surface of the pileus being tomentose, zonate, and brown. *P. subserpens* is usually more extensively effused over the substratum and often extends over the log for several feet. *P. subserpens* is mostly southern in its range and is common on Liquidambar and Lyssa. *T. mollis,* on the other hand, is mostly northern and is usually on species of Populus and Alnus. Both fungi, however, attack other woods.

Habitat.—Acer floridanum, Carpinus sp., Carya sp., Celtis sp., Citrus aurantium, Ficus sp., Fraxinus americana, F. pennsylvanica lanceolata, Gleditsia aquatica, Liquidambar Styraciflua, Lysiloma bahamensis, Nyssa aquatica, N. biflora, Persea americana, Pinus echinata, Planera aquatica, Populus sp., Quercus laurifolia, Q. Shumardii, Q. virginiana, Salix nigra, Ulmus sp., Vitus sp.

Distribution. — Alabama, Florida, Georgia, Illinois, Kentucky, Louisiana, Mississippi, North Carolina, New York, Ohio, Oklahoma, Pennsylvania, South Carolina, Tennessee, Texas, Virginia.

Occurrence. — *Poria subserpens* is one of the most common resupinate polypores of the states bordering the Gulf of Mexico. It is especially abundant on hardwood logs in tupelo-gum swamps. *Nyssa aquatica* is the usual substratum, but *Liquidambar Styraciflua* is frequently attacked.

Cultures. — Isolated from *Quercus Shumardii,* Fort White, Florida, and from *Nyssa biflora,* Stark, Florida. The snow-white mycelium from both isolates exhibits a concentric to radiating type of growth in malt-agar cultures in petri dishes. The two isolates are similar in their growth habits on wood, the mycelium covering both red-gum and white-pine test blocks in one-year-old flask cultures.

Poria subserpens grows faster in the dark than in the light. It also belongs to the rapid-growth group and in the category "high temperature" for optimum growth.[2] The white to "cartridge-buff" or "cream-buff" mycelium covers hardwood blocks (red gum), and eventually radiates in strands or fanlike growth over white-pine blocks, but often does not cover such wood as densely in one-year-old cultures. No pore formation has occurred.

Cultures exhibit a strong positive reaction to tannic acid medium.

Fomes subroseus (Weir) Humphrey and Siggers, Journ. Agric. Res., 47 : 999. 1933

(Plate IV)

Fomes carneus (Nees) Cooke, Grevillea, 14 : 21. 1885.
Fomes Palliseri Berkeley, Grevillea, 10 : 98. 1882. Saccardo, Syll. Fung., 6 : 204. 1888.
Fomes carnea granularis Pk., teste Pilát, 1936.
Fomes carnea subzonata Pk., teste Pilát, 1936.
Polyporus carneus Nees, Nova Acta Nat. Curiosorum, 13, t. 3. 1827.
Trametes subrosea Weir, Rhodora, 25 : 217. 1923.
Trametes arctica Berk., Herb., teste Pilát, 1936.
Trametes carnea (Nees) Pilát, Bull. Soc. Myc. Fr., 48 : 19. 1932.
Trametes carnea Cooke (sense of American students only).

Fructification annual or perennial, sessile, effused-reflexed, usually thin, coriaceous, 2–6 × 2–15 × 0.5–2 cm. (Shope), or resupinate; surface of pileus zonate or azonate, velvety tomentose, "pale drab gray," "wood brown" to blackish behind, becoming radially appressed, fibrillose, or glabrous; margin thin, sterile below, "light mouse gray," "light cinnamon drab"; context 1–5 mm. thick, corky, "fawn color," tubes concolorous, 0.5–4 mm. long each season; mouths "pale Quaker drab," "light gray vinaceous" to "russet vinaceous," concolorous, 3–5, mostly 4–5, to a mm.; basidia hyaline, 5–6 × 10–20 μ (Pilát); spores hyaline, smooth, cylindric, sometimes allantoid, 6–8 × 2–2.5 μ; no cystidia, hyphae seldom branched 3–5 μ (Shope) in diameter.

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[2] The terms used to represent various categories for growth are defined in Paper V (19 [1934] : 305–312) of this series.

Forms.—Trametes arctica, listed here as a synonym, is regarded by Lloyd (10) as a form of *F. subroseus arctica* (Berk.) Lloyd with the surface silvery white and with appressed fibrils. The name *Pol. Palliseri,* also listed here as a synonym, was likewise applied to this plant by Berkeley.

Pilát keeps the name *Trametes carnea* and refers to the plant as *T. carnea* (Nees) Pilát. In view of the extensive use of the species name *subroseus* in pathological literature by Weir (24) and others (22, 25) and in view of the fact that Trametes is a doubtfully practical genus, it seems unwise to return to the use of the name *carnea.*

Allied species. — Fomes subroseus is most closely allied to *F. roseus.* The types of rot produced are indistinguishable. Although the pilei of *F. subroseus* are mostly thin, specimens are found occasionally that resemble the more ungulate types of *F. roseus.* The color of the mycelium of both species varies from white to pink, and the odor of cultures of the two is that of green apples. Nevertheless, the two polypores are distinct in their growth features and may be separated not only on the basis of their rates of development but also on optimum growth temperatures. (See page 51.)

Mounce and Macrae (12) found that both *Fomes subroseus* and *F. roseus* are heterothallic and bipolar with one exception, and that complete interfertility exists between haploid mycelia derived from different sources. The exception is of particular interest because it shows that two cultures of *F. subroseus* from widely separate sources possess one interfertility factor in common. These authors state that the two fungi may be differentiated on the basis of their spore characters. According to them, the failure to obtain clamp connections in any of the many pairings of a haploid mycelium of *F. subroseus* with a haploid mycelium of *F. roseus* only serves to emphasize that these two fungi are distinct.

Separation of *Fomes subroseus* from *F. roseus* on the basis of growth at certain temperatures has been made by Snell, Hutchinson, and Newton (22). A test at 30° C. or 32° C. differentiates these two. *F. subroseus* grows over 32 mm. at 30° C., whereas *F. roseus* grows only about 24 mm. at this temperature. Evidence (22) is also presented to show that the two vary in moisture requirements, or in dryness tolerances with regard to fruiting. *F. roseus* is found in drier places, often on dry hewn timbers, but *F. subroseus* usually grows on logs covered with bark or on wood in situations that are decidedly moist (Pl. IV). *F. roseus* also occurs on worked timbers in the open and on decorticated bolts on top of log piles in well-ventilated places. *F. subrosea,* on the other hand, grows in low places and in parts of the pile protected from drying by grass and ferns.

Points of difference between the two species, *Fomes subroseus* and *F. roseus,* may be summarized as follows:

Fomes subroseus	*Fomes roseus*
1. Rate of growth in culture comparatively fast.	1. Rate of growth in culture comparatively slow.
2. Optimum growth temperature 28°–32° C. with most probable value at 31° C.	2. Optimum growth temperature 28° C.
3. Inhibiting temperature 38° C.	3. Inhibiting temperature 35° C. (22).
4. Requires moist sites with high humidities.	4. Requires relatively drier sites than *F. subroseus.*
5. Spores narrow, cylindrical, slightly curved, allantoid, 4–7 × 1–2 μ; smaller than those of *F. roseus.*	5. Spores elongate-ellipsoid, 5–7 × 2.5–3.5 μ; larger than those of *F. subroseus.*
6. Fruiting bodies generally longer and thinner than those of *F. roseus.*	6. Fruiting bodies generally thicker and less elongate than those of *F. subroseus.*
7. In general, no clamp connections form in pairings of a haploid mycelium of *F. subroseus* with one of *F. roseus.*	7. In general, no clamp connections form in pairings of a haploid mycelium of *F. roseus* with one of *F. subroseus.*

The European species, *Polyporus albocarneogilvidus* sensu Romell, might possibly suggest *F. subroseus* if only a small specimen without a part of the substratum were available for observation. *Pol. albocarneogilvidus* is Trametes-like. The mouths of the tubes are tinted slightly rose, and the fungus forms rather large coriaceous sheets, that is, they are often entirely resupinate.

Polyporus albocarneogilvidus is common around Stockholm on oak, and I have frequently observed it on dead limbs still attached to the trees. The habitat, the substratum, the color (which is not so distinct as in *F. subroseus*), and the larger mouths of this European polypore should readily enable one to distinguish it from *T. subrosea.* I have never seen this European plant in America. The name *Poria micans,* as used by Bresadola with reference to some collections of *Pol. albo-carneogilvidus,* is not acceptable.

Fomes subroseus Feei (*Trametes Feei* Fr.) (Pl. V, Fig. 1) is a tropical plant much like *Fomes subroseus* in size, shape, and color. The fibrillose surface, which is the only distinction between the two, is not always in evidence, and Lloyd (10) states that the two plants merge into each other. Snell, Hutchinson, and Newton (22) report as a result of their tests in comparing *F. roseus, T. subrosea,* and *T. Feei* that *T. Feei* in culture grows more slowly at all temperatures and is inhibited from growing at a lower temperature. It could be differentiated from the other two fungi if grown from 30° to 34° C. The type came from Brazil, and this is apparently the common plant of this group from Brazil. It is reported by Sharp (19) from Mexico and Guatemala.

Trametes Sagraeana, named by Montagne from Cuba, resembles *T. Feei,* though Lloyd (10) points out that most of Montagne's species under this name are *Trametes cupreo-rosea.*

Trametes Sagraeana has a smooth, soft, dull surface and smooth and very minute pores. It differs from *T. Feei,* according to Lloyd, in its more punky context and in having a surface soft to the touch, not hard and fibrillose. Lloyd finds *T. Sagraeana* rare in the West Indies (and believes the several collections from West Indies so referred at the New York Botanical Garden to be *T. cupreo-rosea*). He also states the abundant specimens so referred to by Murrill from Cuba are *T. Feei.*

Trametes cupreo-rosea (Pl. V, Fig. 2) is thin and rigid and is attached by a reduced base (6 × 9 × 0.5 cm.). The surface is striate-fibrillose, pale rosy color (buff pink). The context is thin and hard. The pores are round, medium to large, mostly about 0.5 mm. in diameter, with thin walls; tissue concolorous (10). Lloyd reports that a number of specimens from Brazil are at Kew, and there is a collection from Malay. He states that he has never seen a specimen from the West Indies. A collection of this fungus from Coconut Grove, Florida, is in the Farlow Herbarium, Harvard.

Trametes lilacino-gilva (Pl. VI), according to Lloyd, is in the genus Fomes, is the Australian analogue of *T. Feei* of American tropics, and has about the same color and surface. It differs in having notably larger pores and a more strongly fibrillose surface. The Australian forms all have larger pores than the analogues in the American flora.

Trametes Eucalypti is, according to Lloyd, probably an Australian form of *T. lilacino-gilva* as to color and pores, but has an even pileus corresponding to that of *T. subrosea.*

Trametes roseola is an African species, close to *T. plebeia* in color, but differs in context. The surface is dirty rose, not zoned, and is slightly rugulose. The context is punky, dry, pale salmon ("light ochraceous salmon"). The pores are minute, rigid, 1–2 mm. long, and the spores are globose 4–5 (10).

Trametes plebeia in New Zealand, Indian, and Philippine plants has pinkish-cinnamon context, surface, and pore mouths. The surface of the fruiting body is smooth, dull, minutely velutinate, and soft to the touch; the context is hard and rigid (10). Lloyd (10) reports that Berkely referred the species to *T. plebeia* var. *cubensis* (*Polyporus supinus*) of American tropics, which is not a variety and has no analogy to it.

Habitat.—*Abies balsamea, A. grandis, Alnus rubra, Arbutus Menziesii, Betula occidentalis, B. papyrifera, occidentalis, Chamaecyparis thyoides, Juniperus virginiana, Larix laricina, L. occidentalis, Picea Engelmannii, P. excelsa, P. glauca, P. mariana, P. rubra, Pinus Banksiana, P. contorta, P. monticola, P. palustris, P. ponderosa, P. resinosa, P. rigida, P. strobiformis, P. Strobus, P. taeda, P. virginiana, Prunus amygdalus, P. pennsylvanica, P. persica, P. serotina, Pseudotsuga taxifolia, Quercus borealis maxima, Taxodium distichum, Thuja occidentalis, Tsuga canadensis, T. heterophylla.*

Distribution.—Northwest Territories; Alberta, British Columbia, Manitoba, New Brunswick, Newfoundland, Nova Scotia, Ontario, Quebec, Saskatchewan; Alabama, Arizona, California, Colorado, Connecticut, Delaware, District of Columbia, Florida, Georgia, Idaho, Illinois, Louisiana, Maine, Maryland, Massachusetts, Michigan, Minnesota, Montana, New Hampshire, New Jersey, New Mexico, New York, North Carolina, Oregon, Pennsylvania, Rhode Island, South Carolina, Tennessee, Vermont, Virginia, Washington, West Virginia, Wisconsin.

Occurrence.—*Fomes subroseus* is apparently unknown in Europe. It grows in most sections of the northern United States and Canada. It is not common in Newfoundland, but in general it is most frequent in areas north of the states that border the Gulf of Mexico.

The occurrence of *Fomes subroseus* in the field with reference to that of its closely related ally, *F. roseus,* is significant. *F. subroseus* is most likely to grow on "unworked" timber in which moisture is more plentiful, as in moist log piles it is protected from drying out. *F. roseus,* on the other hand, occurs most frequently on "worked timbers," or on top of piles not so protected (22).

The occurrence of *F. subroseus* on Prunus in Oregon, where it causes much rot in stone-fruit trees, is added evidence of Davidson and Campbell's observation (4) that many normally coniferous species occur on Prunus among the hardwoods.

Cultures. — Isolated from tamarack, Whitmore Lake, Michigan. The fungus is characterized by a white to "shell pink" mycelial growth in culture. Some cultures remain almost white, whereas others may be slightly pink, or streaked with pink or "hazel" to "pecan brown" or "Rood's brown." Poroid areas form in wood-block cultures and appear often on malt-extract agar in petri-dish tests after two weeks. Basidiospores are produced. A few chlamydospores are formed, and clamp connections appear in abundance.

No reaction is exhibited on tannic acid medium.

The growth of *F. subroseus* may be considered moderately rapid and, in contrast with that of *F. roseus,* is so much faster at 31° C. that the two fungi may be distinguished on the basis of different growth rates (22).

Fomes subroseus belongs to the class of fungi that grow more rapidly in the light.

An isolate, reported by Humphrey and Siggers (8), exhibited an optimum temperature for growth at 28° C. The inhibiting temperature was 38° C. The fungus is placed, therefore, in their "intermediate-temperature" group (optimum between 24° and 32° C.).

The effect of moist heat and dry heat upon *Fomes subroseus* in three-quarter-inch wood-block cultures has been tested by Snell (21). This fungus was unable to withstand 131° F. (55° C.) for twelve hours at moist heat, whereas it took 221° F. (105° C.) twelve hours to kill the fungus with dry heat.

Reaction to chemicals. — Certain water-soluble extracts are toxic to *Fomes subroseus.* Water-soluble extract from western red cedar in concentrations of 4 per cent or over greatly retarded the growth of this fungus, according to tests made by Southam and Ehrlich (23).

Resistance of *Fomes subroseus* to sodium fluoride has been tested by Richards (15) and has been compared in its resistance to a number of other wood-destroying fungi. Beginning with the least resistant and ending with the most resistant, the list that follows indicates the relative position of *F. subroseus: Poria incrassata, Polystictus abietinus, Pol. versicolor, Fomes roseus, F. pinicola, F. subroseus, Lenzites saepiaria, Polyporus hirsutus, Fomes Pini* var. *Abietis, F. annosus* (possibly *Polyporus tulipiferus,* identity not certain), and *Lenzites trabea.*

Decay. — The rot caused by *Fomes subroseus* in conifers is identical with that brought about by *F. roseus.* In the incipient stages the wood turns somewhat darker than when sound, but the decayed parts are lighter in color than the brown to be observed in advanced stages of rot (7). Usually pink to red-brown patches appear in more or less elongated areas. These coalesce so as to form larger regions of decay. The wood shrinks on drying and breaks up into cubes.

In juniper there is at first a slight change from red to brown over a considerable area. As the discolorations deepen, fissures begin to appear. Pocket-like areas are formed about the fissures by the shrinkage of the wood on their periphery. Sometimes firm hard wood separates the punky portions and resists further decay. The pockets are most common near the base of the host, and here they often coalesce to form large irregular cavities filled with the brown charcoal-like wood. Overmature trees may be almost hollow at the base. Such specimens may be wind-thrown when the hollow becomes so great that the ring of sapwood cannot adequately support the tree.

In addition to causing rot in conifers, *Fomes subroseus* attacks peach and prune trees. The brown rot has been demonstrated to have been produced by the cytohydrolytic enzymes lignose, cellulose, and hemicellulose. Emulsin, also present in the mycelium, makes available the products from glucoside digestion in the wood (25).

Importance. — Comparatively few fungi which occur on structural woods attack both coniferous and hardwood trees as standing timber. *Fomes subroseus* is a conspicuous example of one fungus that does attack hardwoods and conifers, both living and fallen.

In the East it is commonly regarded as a scavenger fungus on dead coniferous wood, but if it occurs on pulpwood, the damage caused may be greater.

Frequently living junipers are attacked by *Fomes subroseus,* which produces a heartrot in them as well as in *Chamaecyparis thyoides.* A brown cubical rot appears in trees attacked (3).

Losses in prune orchards are large but difficult to evaluate. The damage to the diseased tree is not limited to the heartwood, since the sapwood is attacked. This results in destroying the water-conducting power by reducing the volume and by the stimulation of the growth of tyloses in the xylem vessels (25). Such disturbances give rise to "drouth effects" in the affected tops.

Zeller (25) conducted a survey of prune orchards to determine the extent of damage caused by *Fomes subroseus.* Of 1,261 prune trees in orchards having average horticultural care, 1,212 showed heartrot. Of these, 885 (or 73 per cent) were decayed by *Fomes subroseus.* The pruning cut in 619 (or approximately 70 per cent) of these decayed trees was two inches or more in diameter.

In some localities within the active range of the fungus vigorously growing older orchards do not seem to be affected by heartrot. The lack of heartrot in many orchards seems to be related to the system of pruning adopted by the grower.

Control and prevention in orchards. — In general, heartrot caused by *Fomes subroseus* is less prevalent in prune orchards where the system of pruning used eliminates operations on the main leader branches and trunk, particularly if trees are so trained in early years that the removal of large branches is unnecessary later. Wounds should be treated with an antiseptic dressing, such as Bordeaux paint, made by mixing linseed oil into a Bordeaux dust until a thick, smooth paint is formed (25).

Control and prevention in the forest. — Older trees are more susceptible than younger ones, so that cutting in relatively short rotations should be effective. For Tennessee juniper, Von Schrenk (18) estimated that, if cuttings are made between 65 and 70 years (when the trees average about 12 inches in diameter), substantial control of *Fomes subroseus* will result.

Though coniferous logs are usually removed from the woods soon after cutting, it is necessary at times to store them there. Care in woods storage becomes an especially important problem when large amounts of timber are felled by catastrophic storms (2). Complete submersion of the wood in fresh water before the decay fungus starts prevents rot, but damage from marine borers may result if the water is tidal or brackish. Deep submersion involves, however, high costs of recovery of the logs, and should therefore be avoided (2).

For storage of coniferous pulpwood in the forest, peeling delays the action (9) of such a fungus as *Fomes subroseus,* and if the sticks are stacked on ends in open piles (and preferably off the ground), as is done frequently in Sweden, there will be less decay. Immediate peeling prevents bark beetles and wood borers from laying eggs in the wood, and this practice tends to reduce the incidence of rot. Such a procedure to delay fungus action may be especially justified financially if the wood is to be floated to the mill, a method used in some areas in North America. Debarking increases buoyancy of the wood.

In the North pulpwood is often cut in small lots and allowed to accumulate in the woods or at the point of shipment until a sufficient amount is obtained for selling in larger units. It may be stored for as much as two years before shipping, a practice that favors the development of *Fomes subroseus.* Upon arrival at the mill this wood is often handled like recently felled timber and thrown in with freshly cut sticks, so that additional losses from storage of all wood in the piles may be sustained. Such a practice should be avoided.

Control and prevention at the mill and in use. — In North America pulpwood is stored (*a*) in water, (*b*) on the ground in huge conical piles, and (*c*) in ricks. Water storage prevents decay if the wood is immersed. Log parts above the water level may decay if they remain in the same position for long periods. In the conical piling conditions are usually favorable for decay in the interior of the pile. Wood that has been water-transported from the forest to the mill can be protected from rot (and fire) by a system of overhead water sprays so regulated as to keep it soaked beyond the point favorable for fungus activity. It is impossible to soak dry wood in the piles to such an extent that decay will be prevented throughout the cones. Likewise, spraying of ricked wood, even if both ends of each log are exposed to the direct action of the water, is not generally satisfactory.

As a measure of rot prevention ricking pulpwood in piles raised from the ground on concrete or treated skids or piers is preferable to conical piling. The ricks should be separated by open spaces to allow ventilation. Yard sanitation is always necessary and, regardless of method of piling, the oldest wood in the lot must be used first.

In the South pulpwood deteriorates so rapidly that in general large quantities are not stored for more than four or six weeks. Often the fresh sticks are conveyed directly from barge, railroad car, or truck to the chipping machines.

The possibilities of reducing the activities of fungi in wood used in buildings has been considered. *Fomes subroseus* belongs to the "intermediate temperature" or the "high-temperature" group that includes *Lenzites saepiaria, L. trabea,* and *Trametes serialis*. Hoxie (6) debated the possibility of using heat to retard the development of the comparatively "low temperature" or "dry-rot" fungi in buildings. It was concluded by Snell (21) from culture-block tests (see section entitled "Cultures") that, since a heating system could not supply a temperature much above 125° F., heating practices could not be effective in controlling *F. subroseus*. Too high a temperature for too long a period would be necessary to kill the fungus within the wood. Even for fruit-cannery buildings and other such structures of moist occupancy the heat required to kill such a species as *F. subroseus* or other species in this group could not be satisfactorily obtained. Dry heat, applied occasionally for the purpose of drying out the wood, is, nevertheless, to be recommended.

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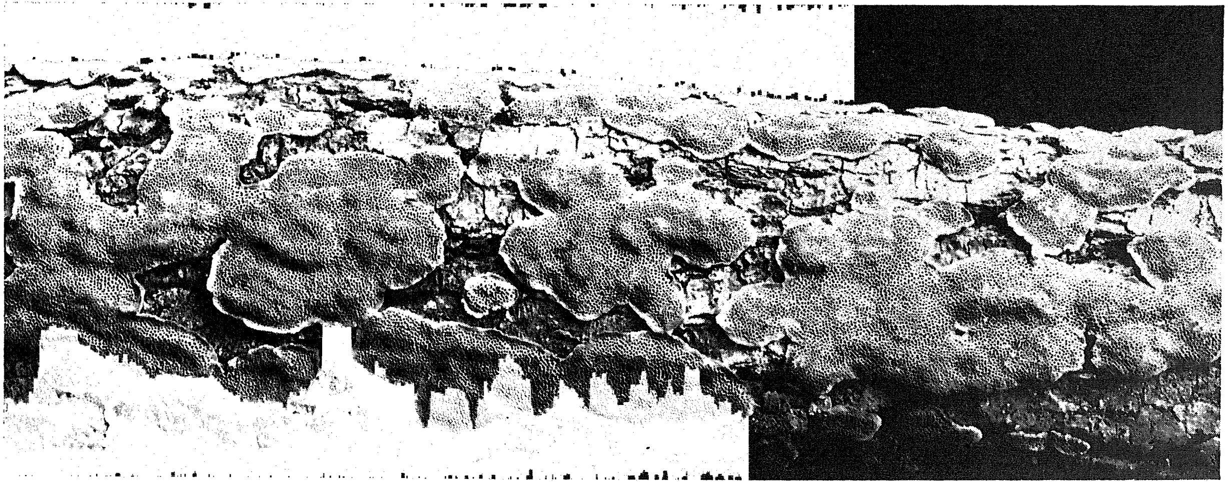
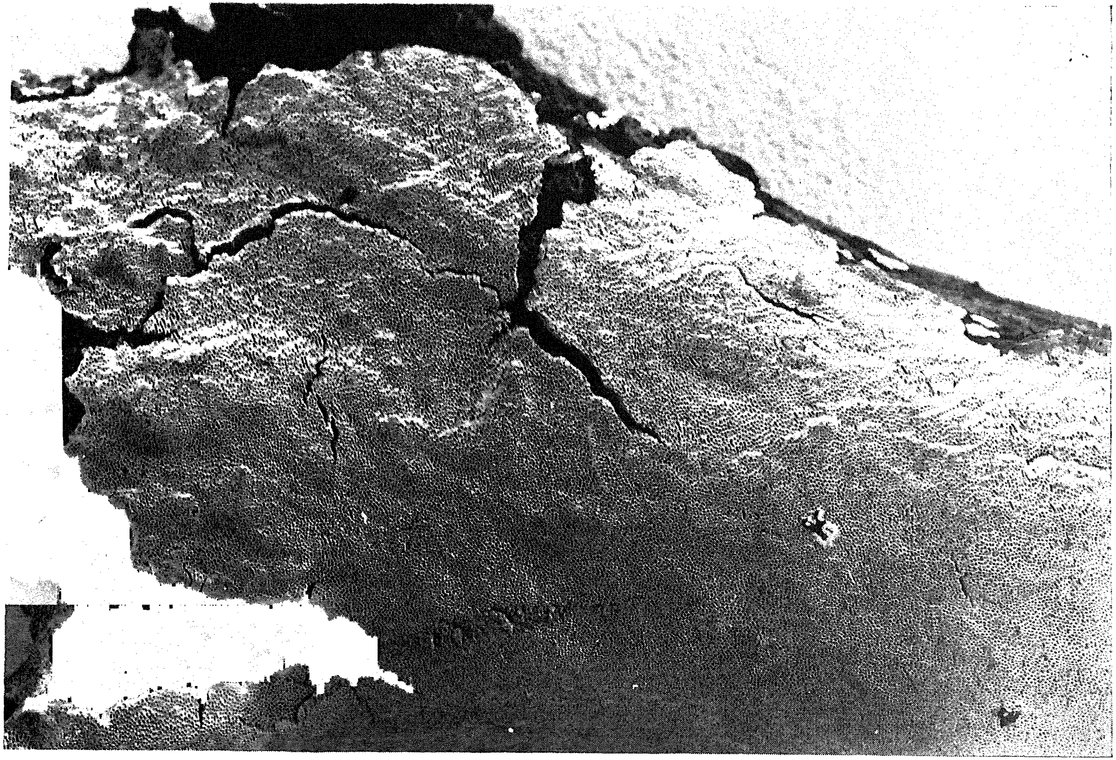
PLATES I–VI

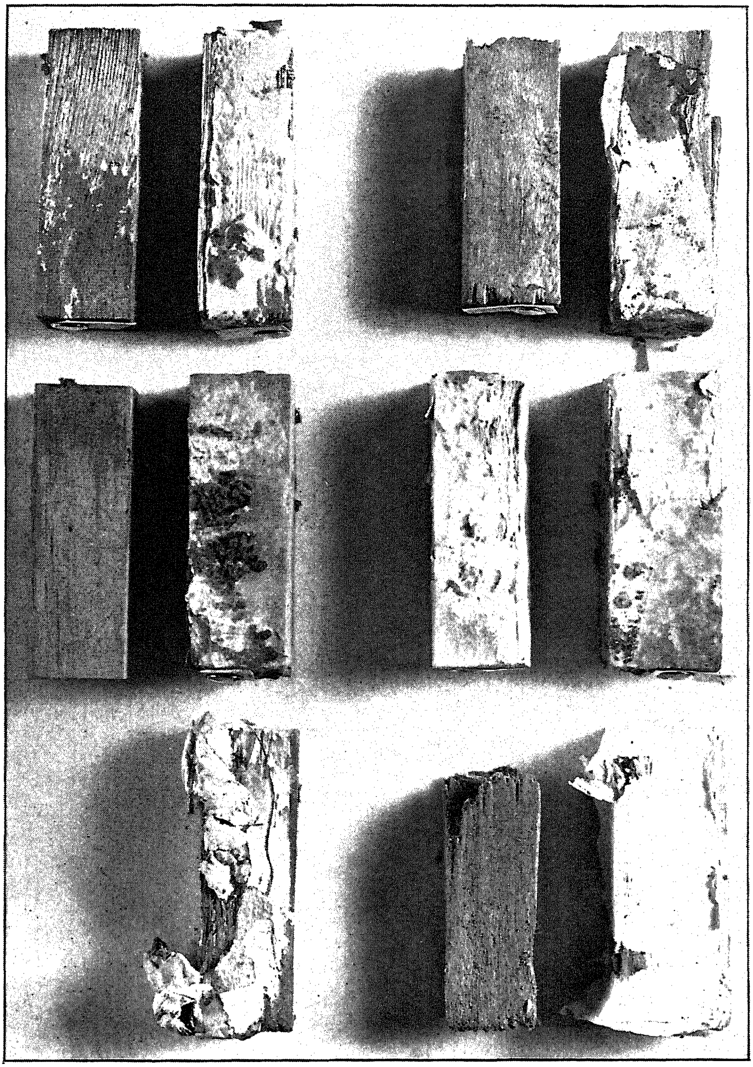
PLATE I



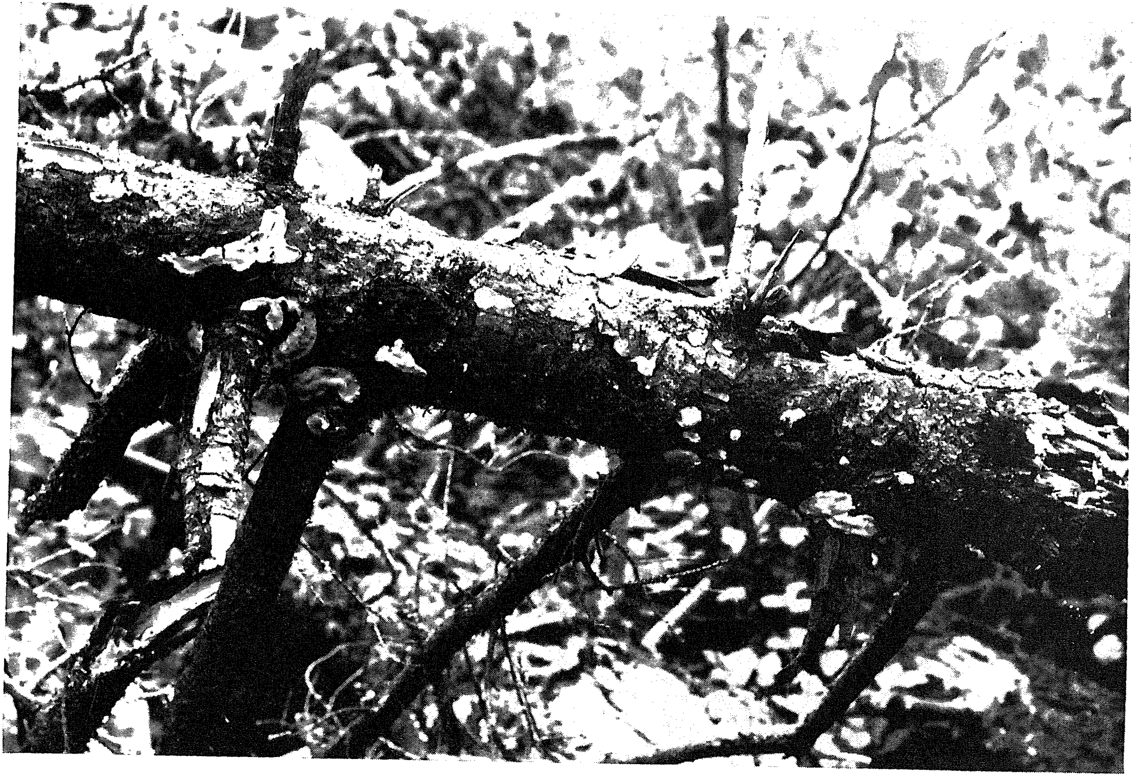
Trametes subserpens on *Nyssa biflora*, Start, Florida



Poria subserpens on *Liquidambar Styraciflua,* Dismal Swamp, Virginia



Trametes subserpens, normally on southern hardwoods, but grows well on both white pine and red gum in culture. White pine blocks to left of center; red gum blocks to right. Top row. Isolate from *Nyssa biflora*. Middle row. Isolate from *Quercus Shumardii*. Botton row. Isolate from *Carpinus spp*.



Fomes subroseus on spruce, Winchendon, Massachusetts

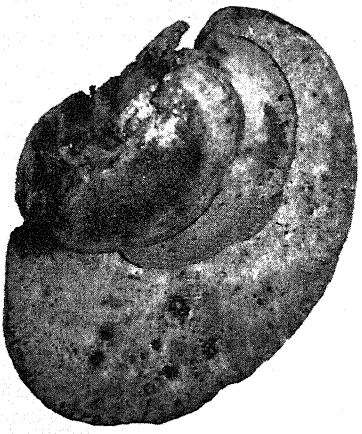


FIG. 1

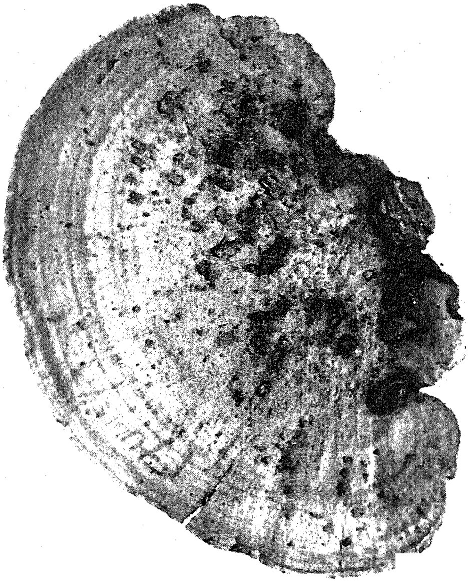
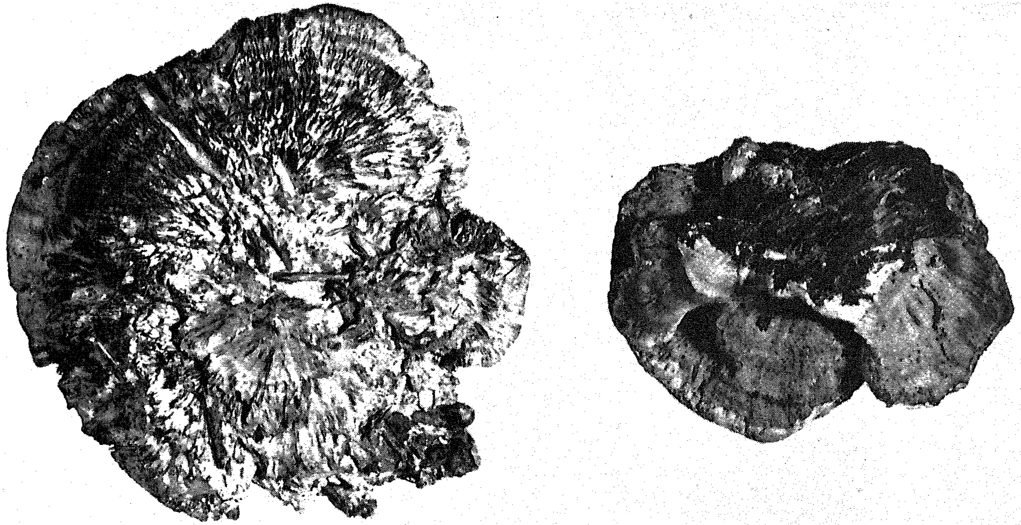


FIG. 2

FIG. 1. *Trametes Feei,* Rio Grande du Sol, Brazil. 51788 Lloyd collection, Beltsville, Maryland. Morphologically this tropical plant appears to be similar to *Fomes subroseus,* but it grows more slowly at all temperatures. It can be further differentiated from *F. subroseus* and *F. roseus* if grown at temperatures from 30° to 34° C.

FIG. 2. *Trametes cupreo-rosea,* Bahia, Brazil. 17497 Lloyd collection, Beltsville, Maryland. This tropical plant has a thin pileus and is attached by a reduced base. A specimen so named from Florida is to be found in the Farlow Herbarium, Harvard



Trametes lilacino-gilva, East Caulfield, Australia. 45652 Lloyd collection, Beltsville, Maryland. Lloyd regarded this plant as the "Australian analogue" of *Trametes Feei* of the American tropics. This fungus needs to be compared with *T. cupreo-rosea, T. Feei,* and the other named species and forms in this group

RED PINE AND THE EUROPEAN PINE-SHOOT MOTH IN SOUTHERN MICHIGAN *

PAUL O. RUDOLF

RED PINE (*Pinus resinosa*) has been remarkably free from natural enemies. Its apparent immunity, combined with its ability to thrive on soils too light and dry for most farm crops, has made it a favored species for planting in southern Lower Michigan. About twenty years ago, however, a pest appeared in the state which now threatens to make the planting of red pine unsafe.[1] This enemy is the European pine-shoot moth (*Rhyacionia buoliana* Schiff.), the larvae of which kill or deform young pine shoots.

OCCURRENCE AND HABITS OF THE MOTH

Known for a long time in Europe as a serious pest of pines, the European pine-shoot moth was first found in the United States in 1914, on Long Island. Evidently it had been introduced on nursery stock from Europe (1, 2). It is now known to occur over the eastern United States as far south as Virginia and west to Michigan and in southern Ontario (3). Apparently it was brought into Michigan on nursery stock from Illinois. The larvae attack many pines, but in North America they prefer red, mugho (*Pinus mugo*), and Scotch (*P. sylvestris*) pines (4, 5).

The adult moths fly during early summer and lay eggs near the tips of twigs, either on the twig itself or on a needle sheath, usually on the upper part of the tree. Young larvae, which are hatched in about ten days, bore into the bases of the needles through the sheath, killing the needles affected. Later in the summer they penetrate the buds and cause a flow of pitch, which hardens into a whitish mass. They overwinter in the bud or under the mass of pitch on the bud. When the trees begin to grow the next spring, the larvae bore into the developing shoots, which curl slightly and die. A little later in the spring, they become full grown, pupate in the burrows, and, in about three weeks, emerge as adults (3).

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* Paper from the Lake States Forest Experiment Station, maintained by the U. S. Department of Agriculture, Forest Service, in coöperation with the University of Minnesota, at University Farm, St. Paul, Minnesota.

[1] During the past decade two other insects have also become serious enemies of red pine in the Lake States. These are the red-headed pine sawfly (*Neodiprion lecontei* Fitch) and the Saratoga spittlebug (*Aphrophora saratogensis* (Fitch)).

Trees up to thirty feet tall or taller are attacked, but ordinarily red-pine stands which are not infested until the trees are over ten feet tall do not become badly injured. Control is possible by cutting off and burning infested tips in late spring or by spraying with arsenicals (3) or DDT. As a rule, neither method is practicable in any but very small plantations.

The moth has a tendency to infest and reinfest the same trees for several years in succession. For this reason it can develop into a serious menace in a small area in from three to five years. For the same reason, however, it does not, by its own power, extend into new areas very rapidly.

AREAS OF INFESTATION IN MICHIGAN

While no detailed survey has been made, a dozen foresters and entomologists[2] familiar with conditions in Lower Michigan have made observations on the occurrence of the moth. Although these observations vary in intensity and accuracy, combined they present the best available over-all picture of the extent of infestation in the Lower Peninsula.

There is some evidence that the moth was introduced into Michigan in the vicinity of Ann Arbor in the early 1920's. It was first found only on ornamental stock, but about ten to fifteen years ago it began to appear in forest plantations. From this point, and possibly from other places to which shipments of infested nursery stock were made, it has spread over the greater part of the southern half of the Lower Peninsula. It is now found westward to Lake Michigan and north throughout the Thumb, and as far as Bay, Midland, Mecosta, and Muskegon counties. The heaviest infestations are reported from Washtenaw, Wayne, Monroe, Livingston, and Shiawassee counties. Moderately heavy infestations have been noted in Saginaw, Jackson, Hillsdale, St. Joseph, Cass, and Berrien counties, and parts of the Thumb. In most of the other counties south of the Bay City–Muskegon line light infestations have been observed.

Generally speaking, ornamental and highway plantings are often badly injured, especially where mugho pine has been included. Indications are that red pine is injured on poor sites more than on good ones. Within plantations insect attacks usually are spotty. In some places 75 per cent or more of the trees are damaged, whereas a short distance away all or most of the trees may be undamaged. Infestations usually do not appear until trees have become two to four feet tall. On small trees injury occurs largely in the tops; taller trees often have much of the infestation in side branches. Plantations bordering hardwood stands appear to be relatively free of the moth.

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[2] The author appreciates information furnished him by Dr. Samuel A. Graham, of the University of Michigan; Dr. E. I. McDaniel and Lester E. Bell, of Michigan State College; Paul E. Slabaugh, of the Soil Conservation Service; and the following foresters of the Michigan Conservation Department: R. L. Olmstead, R. G. Auble, A. H. Boelter, I. H. McFarland, L. O. Miller, R. E. Pfeifer, A. J. Phillips, and Paul Schroeder.

POSSIBLE AREAS OF INFESTATION

The natural range of red pine extended just into the northern part of the southern half of Lower Michigan, but the original stands were removed long ago. Over the years, however, numerous small plantations have been established in this area. As a rough estimate, perhaps 10,000 acres have been planted to it in the thirty-seven counties of the southern half. In this area there are about 66,000 acres of forest land in need of planting on which red pine would be the preferred species. There is also a considerable area suited for this species, which is now in cropland or pasture that should be planted to trees.

CONTROL OF THE MOTH

The following methods of control have been recommended by entomologists: (1) in the late spring cut off and destroy infested twig tips; (2) when the adults emerge apply a spray, made up of (*a*) three pounds of lead arsenate and one quart of fish oil in 100 gallons of water, and repeat it ten days later, or (*b*) three pounds 50-per cent wettable DDT, plus three pounds black leaf 155 in 100 gallons of water, or (*c*) miscible oil and DDT.

One landowner in the Thumb had some twenty acres of plantations which were hard hit by the moth. By picking off infested tips and spraying the trees with 2 per cent DDT powder, he kept damage to a minimum, but this method requires careful watching and a good deal of labor.

It is necessary to spray only the outer edges of individual trees or the borders of large plantations. Yet this method of control is too expensive for general use. Large blocks of plantations probably could be sprayed economically from airplanes or helicopters, but so far there are few such areas in southern Michigan.

Natural control may be more economical than spraying. Already heavily parasitized specimens of pine-shoot moth larvae have been found in Monroe County, and artificial release of parasites along with their natural spread might be quite effective. But the most effective natural control probably is cold winter weather, since the larvae die at temperatures of about −18° F.

THE CLIMATIC ZONE OF NATURAL CONTROL

To learn where cold weather capable of curtailing the spread of the moth occurs, an analysis of the weather records of the last two decades was made for seventy-five places in Lower Michigan, and the number of years in which there were temperatures of −18° F. or lower were plotted on a map (Fig. 1).[3] Areas with similar numbers were grouped into five zones, which are listed below, together with the reasons for grouping them:

Zone 1. — Temperatures of −18° F. or colder occurred once or not at all. In this zone the insect can build up severe infestations and spread with little hindrance.

Zone 2. — Lethal temperatures occur one to three times, or, on the average, about every ten years. Severe infestations can be built up, but the spread of the insects will be more retarded than in Zone 1.

Zone 3. — Lethal temperatures come three to five times, or about every five years. Local infestations can become heavy, but there will not be much opportunity for their spread.

Zone 4. — About every three years, or five to ten times, there will be killing temperatures. Some local infestations may become relatively heavy, but there will be little opportunity for extensive serious attacks or for spread to new localities.

Zone 5. — Killing temperatures occur ten or more times, or every year or two. There is little opportunity for the insect even to establish itself.

If this reasoning is correct, severe damage from moths can be expected in red pine planted in southeastern Michigan within a narrow strip along the St. Clair River and the southern tip of Lake Huron, and within a narrow strip along Lake Michigan from about Ludington to the Indiana border (Zone 1 in Figure 1). Throughout most of the rest of the southern

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[3] Some weaknesses in this procedure are recognized: (1) the duration of the low temperatures is not known; (2) for most of the southern stations the lethal temperature occurred only once in the year recorded, but for others such temperatures occurred two or more times in the year; (3) temperatures at the point where larvae lived may have been either higher or lower than those recorded at weather stations. However, these data are the best available and, despite their drawbacks, are useful.

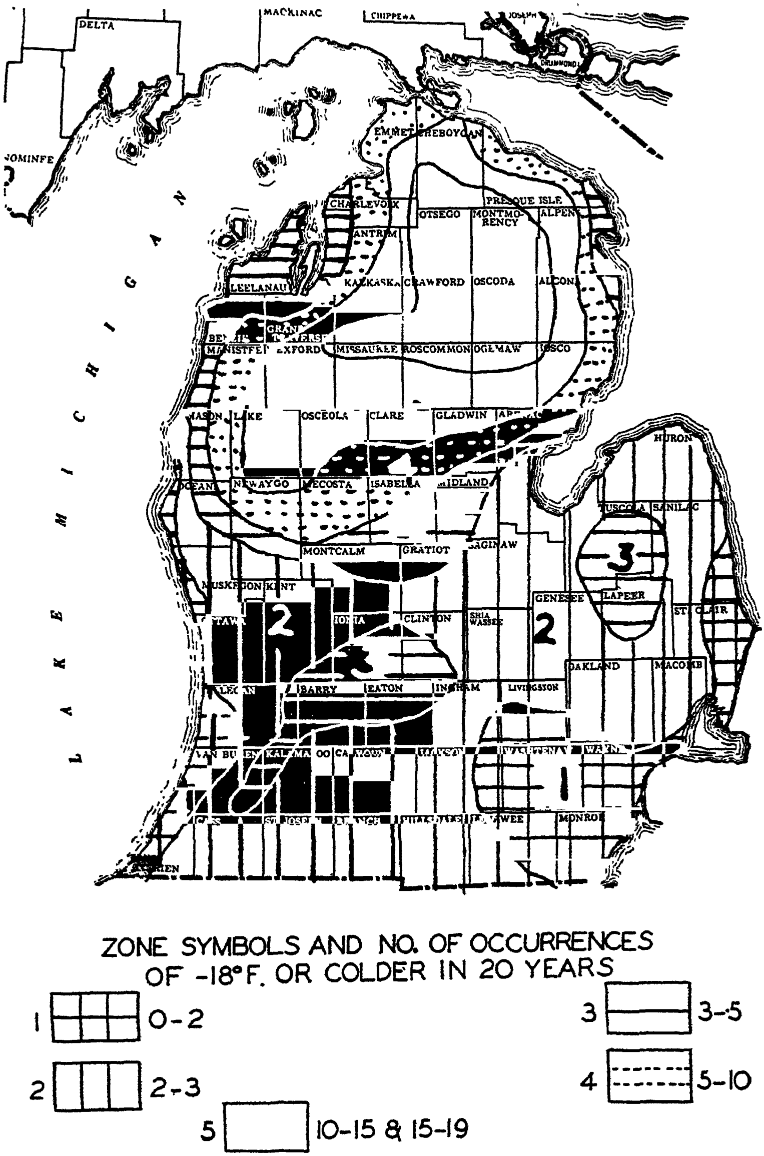

FIGURE 1

half of Lower Michigan (Zone 2) red pine may eventually become heavily damaged. Individual infestations may become severe, but their spread is apt to be highly restricted in portions of Lapeer and Tuscola counties; portions of Clinton, Ionia, Kent, Eaton, Barry, Allegan, Kalamazoo, and Van Buren counties; and in a belt including parts of Arenac, Bay, Midland, Isabella, Mecosta, Gratiot, Montcalm, and Newaygo counties, and extending north to the Lake Michigan shore and up to Charlevoix, and along the Lake Huron shore in Alcona, Alpena, and Presque Isle counties (Zone 3). Throughout the rest of the northern half of the Lower Peninsula the moth either is not likely to establish itself or is not apt to cause serious damage (Zones 4 and 5). For many purposes Zones 1 and 2 could well be combined.

CONTROL MEASURES PROPOSED

In view of the facts now known certain recommendations can be made to minimize the damage from the European pine-shoot moth in Lower Michigan. Some of them are as follows:

1. New red-pine plantations should not be established adjacent to plantings infested with the moth.
2. Present infestations should be controlled wherever additional plantings are contemplated. Special efforts should be made in the western part of the state, where the moth does not yet appear abundant and where rather extensive red-pine plantations already exist.
3. In the eastern tongue of Zone 1, where the infestation is most severe, suitable races of the more resistant ponderosa and Austrian pines should be sought as substitutes for red pine.
4. Red pine should not be planted on poor sites.
5. The use of mugho pine should be discouraged wherever red- or Scotch-pine plantations are to be established.
6. Unless constant vigilance is exercised and controls are applied at the first sign of infestation, red pine should not be planted in the southern half of Lower Michigan, except in Zone 3. Even here some damage is likely to occur if no artificial control is used.
7. From a long-range point of view red pine trees apparently resistant to damage from the moth should be utilized as a source of seed or breeding material for developing resistant planting stock.

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ZOOLOGY

SEA LAMPREY INVESTIGATIONS

II. EGG DEVELOPMENT, MATURITY, EGG PRODUCTION, AND PERCENTAGE OF UNSPAWNED EGGS OF SEA LAMPREYS, *PETROMYZON MARINUS*, CAPTURED IN SEVERAL LAKE HURON TRIBUTARIES *

VERNON C. APPLEGATE

INTRODUCTION

THIS study constitutes the second of a series of reports which embody the findings and results of investigations begun early in 1947 by the Michigan Institute for Fisheries Research on the life history and habits of the predatory sea lamprey. These investigations were initiated and are being carried on in an effort to provide a sound biological basis for any proposed method of reducing or controlling the numbers of this dangerous fish parasite in the upper Great Lakes. The first report of this series deals with the distribution of sea lamprey spawning populations in Michigan streams.[1] The present account is concerned primarily with the biotic potential of this fish. Subsequent studies will delineate other phases of the life history.

All field observations upon which this study is based were made between April 9 and July 10, 1947, on the Ocqueoc River and Carp Creek, Presque Isle County, Michigan. These dates are each within several days of the extreme time limits of the sea lamprey spawning migration into these streams. The peak of the migration occurred during the second week in June. In Carp Creek a weir and a trap were operated, and the entire sea lamprey run, 1,617 individuals, was captured. All these specimens were examined at capture by the writer. In the Ocqueoc River the spawning migration was unimpeded, but large samples of the migrants were obtained and examined. The entire ovaries were removed from seventy migrant females and preserved in F-A-A (a solution of formalin, acetic acid, and alcohol). Fifty-eight of these specimens were taken in Carp Creek, eight in the Ocqueoc River, one in Ocqueoc Lake (in a gill net, presumably while migrating through the lake to the spawning grounds in the river upstream from the lake), and three were captured in the Cheboygan River below the power dam in the city of Cheboygan, Cheboygan County. Pertinent mensural data were collected on all specimens at the time of capture. The specimens utilized were deliberately selected for length so that all size groups in the migrant population would be adequately represented among the data. To obtain a better measure of the variability in egg production at a given size additional specimens were collected in the 17.0–18.0-inch (432–457 mm.) size group. This group embraces the mean length (17.4 inches, 442 mm.)[2] of the 603 females which entered Carp Creek in 1947.

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* Contribution from the Institute for Fisheries Research of the Michigan Department of Conservation. Some financial assistance in this project was contributed by the Associated Fishing Tackle Manufacturers' Trust Fund for Fisheries Research in the University of Michigan.

[1] Applegate, Vernon C., "An Inventory of Spawning Streams of the Sea Lamprey, *Petromyzon marinus*, in Michigan," *Mich. Inst. for Fish Res., Tech. Rept.*, No. 1 (forthcoming).

The earliest specimens represented in my series of seventy migrant females (Nos. 1, 2, and 3) were speared just before midnight on April 15, and on April 16, in Hammond Bay, about one hundred feet offshore from the mouth of Carp Creek. They undoubtedly represent the earliest migrants arriving from deeper waters of Lake Huron as determined by repeated observations during the period April 9 through April 15. Those observed were making no effort to enter the creek at that time. They arrived on the gravel fan off the mouth of the creek about two hours after dark and dropped back into deeper water with the beginning of dawn. Upstream migration began on or about April 19. After April 15–16 specimens for this stuly were collected at five- to ten-day intervals throughout the migratory period.

In addition to the gravid females, forty spent and dead or dying specimens were collected in the Ocqueoc River, the Little Ocqueoc River (a tributary of the former), and in the Manistique River (a tributary of Lake Michigan), Schoolcraft County (one specimen). The remnants of the ovaries and all eggs remaining in the body cavity were removed and preserved in F-A-A.

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[2] The data from which certain averages mentioned in this report are derived will be discussed in detail in a subsequent report.

EGG DEVELOPMENT AND MATURITY IN SPAWNING MIGRANTS

Female sea lampreys, when sexually mature and ripe, have a single elongate ovary extending nearly the entire length of the body cavity (Pl. I). The anterior tip of the ovary begins just behind the last pair of gill pouches, and the organ extends posteriorly to the anus. The ovary, when the eggs are ripe, or nearly so, constitutes a large percentage of the total weight of the female. In eighteen ripe or nearly ripe females collected between June 12 and June 26 the ovaries averaged 22.4 per cent of the total weights of the females and ranged from 13.6 to 29.5 per cent. On the other hand, in eight less mature females collected between April 15 and April 30, at the beginning of the run, the ovaries averaged only 11.3 per cent of the total weights of the females and ranged from 8.2 to 15.8 per cent.

When the eggs are fully ripe, they are shed into the coelom (body cavity) and are forced to the exterior during the spawning act through a pair of genital pores. One of these pores enters each side of the urogenital sinus, which is provided with a median pore to the outside on a papilla situated behind the anus. No Müllerian ducts (nor *vasa efferentia* in the male) are present, unless the paired pores represent them.. The ripe eggs are spherical to pear-shaped in form and sandy to light tan in color. At the time of extrusion they are nonbuoyant and somewhat adhesive; sand grains stick to them readily.

In order to determine the nature of the ova present throughout a given ovary and the degree of egg development (i.e. stage of maturity) in females at different times during the spawning run, diameter measurements of ova were taken from eight specimens. They were made by means of an ocular micrometer in a compound binocular microscope; calibration of the ocular micrometer with a stage micrometer indicated a value of 0.05 mm. for each micrometer unit; diameters were therefore determined to the nearest 0.05 mm.

Owing to the effects of preservation and the natural shape of many of the eggs, very few were perfectly symmetrical. In order to avoid any selection of the longest or shortest diameter the micrometer was fixed in a vertical position upon the field of vision, and the diameter parallel to the graduations on the micrometer was measured. This gave the longest diameter of some eggs, the shortest of others, or intermediate measurements between the two. Clark (1925) tested this method and found it to be reliable. It was used again by the same author (Clark, 1934) and by Carbine (1944) with excellent results. Although the eggs appeared equally turgid and well formed both after preservation and when examined fresh, I do not know if any small shrinkage occurred because of preservation. If any did occur, it could hardly have been an appreciable amount. In any event, the relative values obtained would keep their identity.

The first ovary analyzed was from a 12.6-inch (320 mm.) female taken in the Carp Creek weir on June 16, 1947. The weight of this female was 70 grams, and the ovary weighed 13.50 grams or 19.2 per cent of the weight of the specimen. Sections were removed from the anterior, middle, and posterior thirds of the ovary. The eggs were teased out of the sections, a random sample of 500 eggs was obtained, and these eggs were measured. A frequency diagram of these ovum measurements appears in Figure 1. For each section the average diameter and range were as follows:

Section	*Average diameter*	*Range*
Anterior	0.87 mm.	0.35–1.10 mm.
Mid	0.90	0.50–1.15
Posterior	0.82	0.35–1.15

It is apparent from these data that the ova in the midportion of the ovary are slightly larger than those developing in the front and back portions. The difference is so small, however — 0.03 mm. and 0.08 mm. — that no appreciable error is involved in the other measurements and calculations made from midsections only.

Jordan (1905) reported that "A. Mueller, in 1865, showed that all the ova in the lamprey were of the same size, and that after spawning, no small reproductive bodies remained to be developed later." It is not quite clear to which species he has reference. In the light of the examination of this and subsequent specimens of the sea lamprey, this statement is in need of qualification. Three categories of ova were present in the material examined. First, there are the developing ova (represented by the highest modes in Figure 1). These are by far the most numerous in the ovary and are the eggs which are destined to be spawned very shortly. Second, there are ova of apparently retarded development which I term "partially developed ova" (these are represented in Figure 1 by each low mode to the left of the high ones representing the developing ova). The partially developed ova are scattered throughout the ovary and differ from the larger ones only in size and amount of contained yolk; the form appears similar. Such eggs are present in variable numbers in all females,

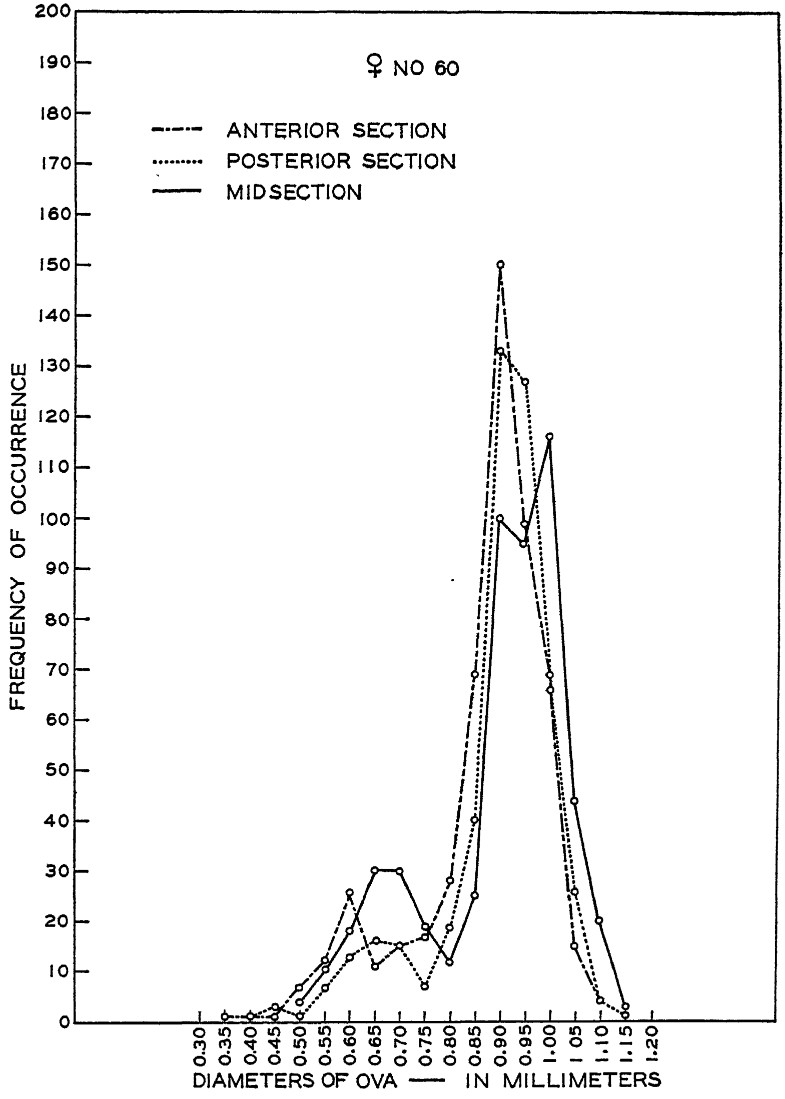

FIG. 1. Frequency distributions of ovum diameter measurements made from samples taken from the anterior, mid, and posterior sections of the same ovary

but are more commonly found in the smallest specimens and are quite infrequent in the larger ones. The individual represented in Figure 1 is believed to have contained the largest number of partially developed ova in the entire series studied. It probably represents the greatest proportion of this kind of eggs present in the females of an average spawning run. In examining females in which the eggs had burst into the coelom I found that some of these retarded ova are extruded with the fully developed ones. The majority, however, remain trapped in the remnants of the ovary. Other experiments have shown that those that are extruded with the mature ova can become fertilized, but it is not known whether full development to hatched larvae occurs. Ova in the third category are microscopic in size, generally between 0.20 and 0.30 mm. in diameter. They are variable in number in different females, but as a rule they are quite numerous, although their total number is always less than that of the more mature eggs. These ova, unlike those of the other two categories, are translucent, contain little or no yolk, and are still firmly attached to pedicels in the gonad. Since they could readily be found only in the frayed ovarian tissue of spent females, they do not enter into any of the measurements or counts that were made. They were too small to be seen with the magnification used in making the counts and measurements of the other two kinds of eggs. It seems logical to conclude either that mature ova of the sea lamprey develop at the expense of the retarded and undeveloped ones or that some mechanical impediment aborts the development of the latter; both probably occur. I do not believe that either of these categories could be construed to represent a potential reserve stock that would enable the female to spawn again in the following year.

Jordan (1905) further states that "... the most careful microscopical examination of ovaries or testes has failed to reveal any evidence of new gonads or reproductive bodies." My preliminary examinations seem to confirm this. Even if it should be demonstrated that the ovaries or testes of some spent sea lampreys contain spermatogonia (and spermatocytes) or oögonia (and oöcytes), the presence of such germ-cell stages need not necessarily indicate that these specimens would have lived to spawn in another season. Weisel (1947) has shown the presence of these germ cells in spent, landlocked sockeye salmon (*Oncorhynchus nerka*) of both sexes. Individuals of this species become sexually mature and spawn only once, dying very shortly thereafter. Weisel concluded that some factor, other than a potential supply of germ cells, limits the spawning of this Pacific salmon to a single season.

In general, the developmental stages of the ova found in the sea lamprey are similar to those found in other fishes that spawn during a single brief period, that is, the maturing eggs constitute a single size group more or less discrete from the immature ova. The sea lamprey, however, differs fundamentally from such fishes in one respect. In females of those species that spawn in several or many seasons the immature eggs greatly outnumber the maturing eggs at the time of spawning (Carbine, 1944). It is here demonstrated that in the sea lampreys studied the maturing eggs outnumbered the undeveloped ones present. This fact, the absence of any germ-cell stages, and the nature of other physiological changes at spawning I consider very strong evidence that the sea lamprey spawns but once and then dies.

Ovum diameters were obtained from seven additional specimens. Six of these were selected from the series available, so that one of the earliest and one of the latest migrants and four migrants taken on scattered intervening dates were represented. For uniformity these were selected to fall within 17.0 and 17.5 inches (432 and 445 mm.) in total length. These factors alone governed the selection of the specimens. A seventh specimen (No. S-41) of comparable length (16.4 inches, 417 mm.), taken on the spawning grounds, was chosen for examination, since in this female the bulk of the eggs had burst into the coelom and presumably represented fully mature eggs. The data for six specimens are based on sample sections removed from the previously described midregion of each ovary. These samples were teased apart, and a randon sample of 500 ova from each was measured. For specimen No. S-41 a random sample of 500 ova was taken from the total number that were loose in the coelom. The data obtained for all seven specimens are presented in Table I, and those for six of the specimens (including No. S-41) are graphically portrayed in Figure 2.

Ova among the earliest spawning migrants entering a stream are about three fourths of a millimeter in diameter (average, 0.75 mm.; range, 0.40–0.85 mm.). Fully mature eggs average about 1.10 millimeters in diameter and range from 0.80 to 1.25 millimeters. Migrants entering the stream on progressively later dates demonstrate progressively more advanced stages of egg development (Table I). It should be pointed out, however, that the smooth progression of increasing average ovum diam-

TABLE I

Diameter of Developing Ova in Seven Female Sea Lampreys Collected at Intervals during the Spawning Migration

Specimen number	Place of collection	Date of collection	Total length (inches)	Total length (in mm.)	Weight (grams)	Condition of ovary	Ovum diameters (in mm.)*	
							Average	Range
2	Hammond Bay — off mouth of Carp Creek	April 16, 1947	17.2	437	222	Green	0.75	0.40–0.85
4	Carp Creek weir	April 25, 1947	17.2	437	134	Green	0.76	0.50–0.95
14	Carp Creek weir	May 12, 1947	17.2	437	165	Green	0.83	0.40–1.00
23	Carp Creek weir	May 25, 1947	17.5	445	168	Green	0.91	0.45–1.10
36	Carp Creek weir	June 10, 1947	17.2	437	246	Green	0.98	0.45–1.20
73	Carp Creek weir	July 2, 1947	17.0	432	178	Ripe	1.03	0.60–1.25
S-41	Ocqueoc River	June 28, 1947	16.4	417	203	Eggs loose in coelom	1.10	0.80–1.25

* Range and averages for each specimen based on random sample of 500 ova taken from the midsection of the ovary.

eters with later dates of capture in Table I is most likely fortuitous. In examining nearly a thousand females I found that many degrees of maturity were represented among the specimens taken on a single day, particularly in midseason. The mean values listed in Table I are considered to represent the *average* degree of egg development in females entering the stream on the dates indicated.

In migrants entering the stream in mid-April 68.4 per cent of the development of the ova had still to take place while the female was in the stream (computed on the basis of the relative volumetric proportions of individual ova with the assumption that they are perfectly spherical). In females that entered the stream from mid-June until the end of the run the eggs were very nearly fully developed, but not so far along as to have burst into the body cavity. In only a few of the late migrants, including the last ones taken in July, were any eggs found in the coelom.

In the frequency polygons presented in Figure 2 a uniform horizontal scale was used for all six projections. Thus the relative degrees of maturity of the specimens examined is apparent in the progressive shifting of the frequency distributions from left to right. Of particular interest is the great scarcity of partially developed eggs found in most of the samples represented.

EGG PRODUCTION

Of the 70 specimens utilized to determine egg production, actual numerical counts were made of the ova in 10 specimens. These include the largest (21.1 inches, 536 mm.) and the smallest (12.6 inches, 320 mm.) females in the series and eight of intermediate size. Prior to making each of these counts, the total volume and the total weight of the ovary were obtained. A sample section was removed from the middle of the length of the ovary, and the volume and weight of the sample were likewise determined. Volumes were secured by a system of displacement of water into a cylinder bearing 0.2 cc. graduations and were read to the nearest 0.1 cc. Weights were obtained to the nearest 0.01 gram on a chemical balance. Excess moisture was removed as consistently as possible from all ovaries and sections before any determinations were made. Eggs in the sample section were counted first, and the total production was computed by direct proportion for both the volumetric and the gravimetric data. When the balance of the ova had been counted, the calculated totals by both techniques could be compared for accuracy. This procedure was followed for all ten specimens and the results are incorporated in Table II.

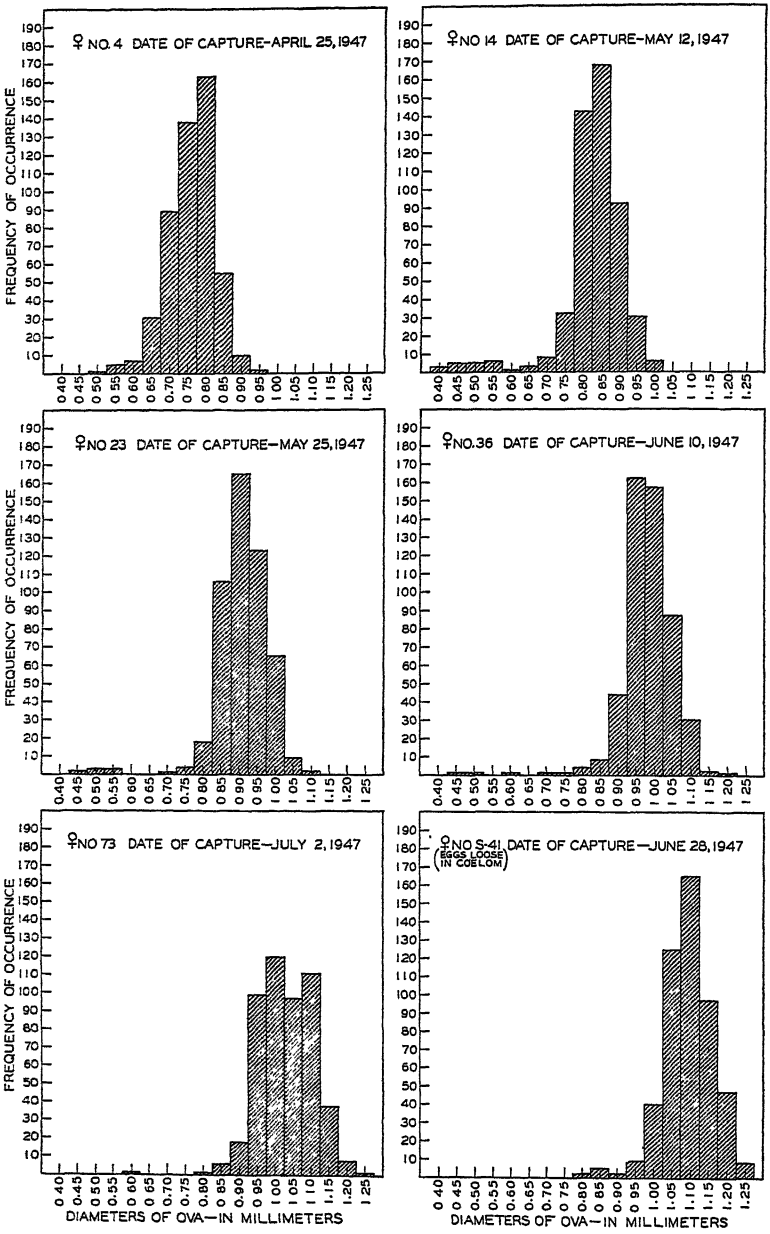

FIGURE 2

(For the explanation of the charts see the facing page.)

There was really very little difference in the accuracy of the two techniques (Table II). By the volumetric technique the calculated totals differed from the actual totals (numerical counts) by amounts varying from 0.0 to 10.4 per cent. The mean percentage error was +3.2. By the gravimetric technique deviations from actual totals varied from 0.0 to 9.7 per cent, with a mean percentage error of +2.5. The mean percentage errors of the two techniques are based on an algebraic average of the individual percentage errors. Although in most cases this statistic might produce an inaccurate result, it is felt that in this instance its application is justified. A mean error based on the algebraic sum of deviations expressed in numbers of eggs allows individual specimens (such as a small one of low egg count) to influence the results unduly, that is, a female which contains only 25,000 eggs and for which there is a ±1,000 egg deviation between calculated and actual totals has a large percentage error. This latter statistic is a very real measure of the efficiency of the calculating technique in that particular case. However, an equal numerical deviation in a larger and more productive specimen results in a much lower percentage error. It therefore follows that, if errors expressed in numbers of eggs tend to remain more or less constant (as they may if there is some small bias in the technique), too many small test specimens or too many large test specimens in a series will undoubtedly render too high or too low a mean error.

The preponderance of positive errors in calculating total egg production suggests some small bias in the techniques or procedures used. It is felt that the mean percentage error, as computed, provides the best measure of any bias, if it exists, resulting from some defect in the procedure. The mean percentage errors in this study are so small, however, that they may very well fall within the limits of chance occurrence. Consequently, the application of any small correction factor to the calculated data on egg production is not suggested.

The gravimetric method was utilized in calculating total egg production for the remaining sixty specimens because, apparently, the smallest

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EXPLANATION OF FIGURE 2

FIG. 2. Frequency distributions of ovum diameter measurements from sea lampreys taken on successive dates. Specimen No. 4 (represented at upper left) was a very early spawning migrant; specimens numbered 14, 23, and 26 were captured prior to or during the peak of the run; specimen No. 73 was taken after the peak of the run. Specimen No. S-41 (represented at the lower right) was a female in which the fully ripe eggs had burst into the coelom

TABLE II

EGG PRODUCTION OF TEN FEMALE SEA LAMPREYS AS DETERMINED BY NUMERICAL COUNTS COMPARED WITH VALUES AS DETERMINED VOLUMETRICALLY AND GRAVIMETRICALLY FROM SAMPLE SECTIONS OF THE OVARIES

1. Specimen number	60	58	57	70	44	73	56	23	66	63
2. Place of capture	Occqueoc River	Carp Creek	Carp Creek	Carp Creek	Carp Creek	Carp Creek	Carp Creek	Carp Creek	Cheboygan River	Ocqueoc River
3. Date	6/16/47	6/15/47	6/15/47	6/26/47	6/11/47	7/2/47	6/15/47	5/25/47	6/26/47	6/20/47
4. Total length in inches	12.6	14.2	14.9	15.0	16.3	17.0	17.1	17.5	18.0	21.1
5. Total length in millimeters	320	361	378	381	414	432	434	445	457	536
6. Weight in grams	70	100	137	128	182	178	165	168	236	316
7. Total eggs by numerical count	23,986	21,000	48,694	66,537	53,012	67,604	59,185	55,486	69,736	107,138
8. Total eggs in sample section, by actual count	1,343	1,962	9,372	8,594	8,929	6,951	3,470	3,684	6,686	5,703
9. Total volume of ovary (cc.)	12.5	13.6	34.8	37.6	37.9	55.5	46.7	28.2	66.3	76.9
10. Volume of sample section (cc.)	0.7	1.3	6.6	4.4	6.0	5.2	2.7	2.0	6.0	3.9
11. Calculated number of eggs	23,982	20,526	49,416	73,440	56,402	74,189	60,018	51,944	73,880	112,451
12. Percentage error	0.0	− 2.3	+ 1.5	+ 10.4	+ 6.4	+ 9.7	+ 1.4	− 6.4	+ 5.9	+ 5.0
13. Total weight of ovary (grams)	13.50	13.93	32.49	34.86	36.30	51.55	45.97	28.81	65.18	73.44
14. Weight of sample section (grams)	0.68	1.30	5.70	4.56	5.93	5.15	2.72	1.97	6.11	3.86
15. Calculated number of eggs	26,662	21,024	53,420	65,699	54,658	69,577	58,646	53,876	71,325	108,505
16. Percentage error	+ 11.1	0.0	+ 9.7	− 1.3	+ 3.1	+ 2.9	− 0.9	− 2.9	+ 2.3	+ 1.3
17. Egg production of specimen*	24,021	21,000	48,694	66,552	53,026	67,617	59,198	55,491	69,806	107,138

* Where these figures differ slightly from actual numerical counts listed in line 7, it is due to the addition of a small number of eggs not preserved, but counted, at the time of collection.

TABLE III

DATA ON SIZE, WEIGHT, AND EGG PRODUCTION FOR SEVENTY SEA LAMPREYS, WITH WEIGHTS OF OVARIES AND CALCULATED NUMBER OF EGGS PRODUCED

Specimen number	Total length (inches)	Total length (mm.)	Total weight (grams)	Weight of ovary (grams)	Calculated egg production	Correction*	Total egg production
60	12.6	320	70	13.50	...	..	24,021†
61	12.6	320	61	11.88	31,162	44	31,206
28	13.4	340	81	11.31	41,959	37	41,996
37	13.7	348	101	13.90	36,372	16	36,388
59	13.9	353	90	20.65	46,387	51	46,438
58	14.2	361	100	13.93	...	..	21,000†
21	14.4	366	104	6.62	42,103	19	42,122
16	14.6	371	129	14.67	37,735	40	37,775
53	14.6	371	100	21.85	50,449	22	50,471
31	14.6	371	137	19.56	55,898	56	55,954
54	14.7	373	92	16.32	37,445	24	37,469
49	14.7	373	99	22.98	41,910	6	41,916
57	14.9	378	137	32.49	...	..	48,694†
13	15.0	381	122	15.75	46,622	8	46,630
70	15.0	381	128	34.86	...	..	66,552†
7	15.1	384	135	12.97	38,335	0	38,335
3	15.3	389	110	10.37	45,776	0	45,776
55	15.5	394	110	20.20	38,294	8	38,302
51	15.5	394	136	38.97	46,266	15	46,281
38	15.5	394	179	31.85	74,917	55	74,972
46	15.9	404	132	26.46	48,875	5	48,880
47	16.0	406	150	31.38	44,203	2	44,205
34	16.1	409	137	18.90	46,417	10	46,427
48	16.2	411	160	38.66	57,954	9	57,963
44	16.3	414	182	36.30	...	..	53,026†
15	16.4	417	142	16.98	61,023	0	61,023
1	16.7	424	149	16.43	57,519	20	57,539
52	16.8	427	158	43.65	69,236	1	69,237
22	16.9	429	143	20.55	43,784	24	43,808
26	17.0	432	170	19.65	43,976	34	44,010
19	17.0	432	151	22.52	65,953	18	65,971
73	17.0	432	178	51.55	...	..	67,617†
56	17.1	434	165	45.97	...	..	59,198†
4	17.2	437	134	13.40	48,183	17	48,200
36	17.2	437	246	36.17	52,569	2	52,571
14	17.2	437	165	23.10	59,663	11	59,674
18	17.2	437	175	21.93	61,970	2	61,972
2	17.2	437	222	22.97	80,440	0	80,440
9	17.3	439	155	13.70	58,423	0	58,423
69	17.3	439	176	33.82	69,657	51	69,708
27	17.3	439	198	31.38	82,373	16	82,389
23	17.5	445	168	28.81	...	..	55,491†
12	17.8	452	182	14.55	55,801	12	55,813
66	18.0	457	236	65.18	...	..	69,806†
68	18.0	457	216	40.41	73,688	0	73,688
35	18.0	457	253	40.28	84,330	34	84,364
41	18.0	457	228	49.52	91,373	21	91,394
40	18.1	460	216	48.61	77,425	0	77,425
65	18.2	462	222	65.45	83,261	72	83,333
5	18.4	467	179	14.72	47,670	48	47,718
50	18.4	467	198	47.02	60,912	3	60,915
20	18.5	470	236	45.54	80,135	8	80,143
11	18.6	472	183	13.52	61,821	37	61,858
32	18.6	472	251	40.32	77,898	9	77,907
6	19.0	483	202	26.92	53,147	0	53,147
42	19.0	483	186	30.04	60,675	25	60,700
8	19.0	483	226	35.82	73,501	0	73,501
67	19.0	483	283	77.95	86,829	15	86,844
39	19.2	488	277	54.45	77,481	5	77,486
30	19.4	493	303	58.53	79,934	14	79,948
29	19.6	498	285	49.02	73,101	10	73,111
45	19.6	498	262	35.55	91,414	18	91,432
33	19.7	500	231	32.78	82,299	21	82,320
24	19.7	500	285	56.67	97,263	25	97,288
10	19.8	503	240	26.31	76,830	6	76,836
17	20.2	513	328	48.31	93,881	16	93,897
43	20.3	516	296	56.72	87,118	12	87,130
25	20.5	521	221	37.00	76,223	12	76,235
62	20.5	521	270	59.55	94,515	11	94,526
63	21.1	536	316	73.44	...	..	107,138†

* Number of eggs not preserved at time of collection.

† Total number of eggs determined by numerical count (see Table I).

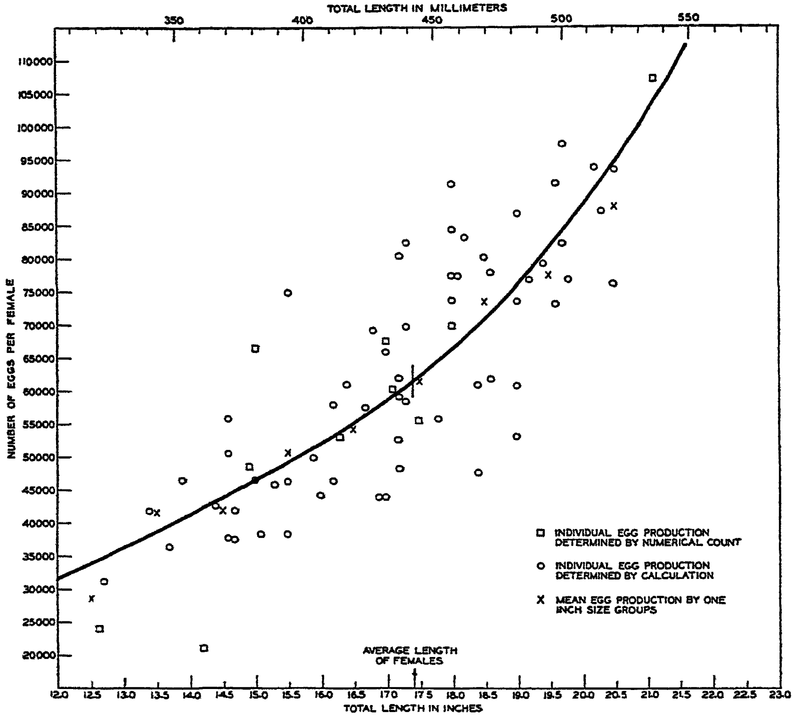

FIG. 3. Relationship between the number of eggs produced and the total length of the fish for seventy sea lampreys

TABLE IV

ESTIMATED MEAN EGG PRODUCTION BY ONE-INCH SIZE GROUPS AS DETERMINED FROM THE CURVE PROJECTED IN FIGURE 3, AND MEAN DEVIATION FOR EACH GROUP

Midpoint of size group (inches)	*Mean egg production*	*Mean deviation*
12.5	34,000	. . . *
13.5	38,700	4,449
14.5	43,800	7,805
15.5	48,300	8,960
16.5	55,200	7,287
17.5	62,200	8,541
18.5	70,600	10,560
19.5	81,900	9,896
20.5	94,800	6,853
21.5	110,300	. . . *

* Too few specimens to warrant computation.

error was involved in this technique and because the laboratory procedure is more rapid by this method. Data on size, weight, and egg production have been tabulated in order of increasing total length of specimens in Table III. If data are available for more than one specimen of a given length, these are listed in order of increasing egg production. These data have been plotted upon two graphs to illustrate the relationship between egg production and total length (Fig. 3) and between egg production and weight (Fig. 4).

The first property evident in these figures is that the number of eggs produced by the sea lamprey varies greatly at any particular length or weight. Mean egg production was computed by one-inch size groups and by 50-gram weight groups, and these values were plotted upon the

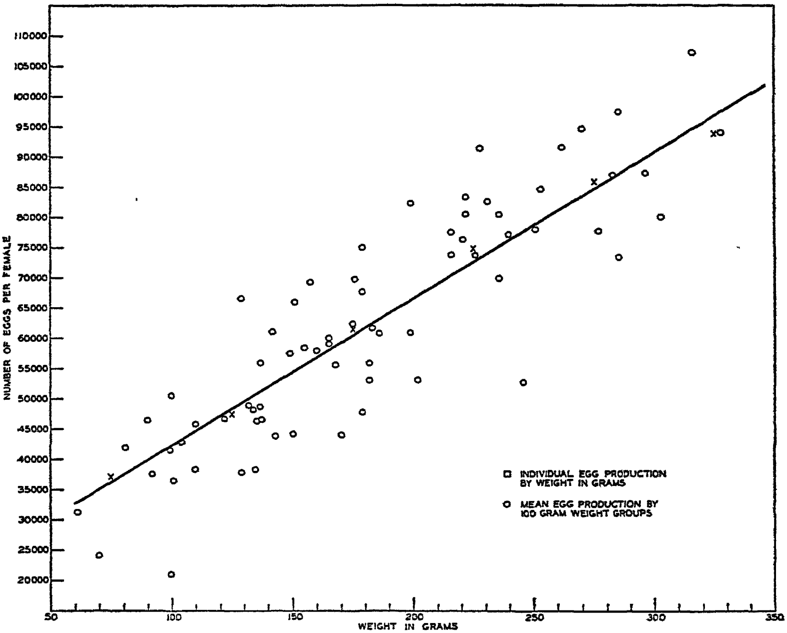

FIG. 4. Relationship between the number of eggs produced and the weight of the fish for seventy sea lampreys

respective graphs. The curves appearing in Figures 3 and 4 have been fitted by inspection to these mean values. The number of eggs produced increases quite rapidly with increase in total length; however, with increasing weight egg production is more directly proportional. The low-

TABLE V

NUMBER OF UNSPAWNED EGGS (DEVELOPED AND PARTIALLY DEVELOPED) IN FORTY SPENT AND DEAD OR DYING SEA LAMPREYS AND ESTIMATED PERCENTAGE OF POTENTIAL EGG PRODUCTION UNSPAWNED FOR EACH INDIVIDUAL

Specimen number	Date of collection (1947)	Total length (inches)	Total length (mm.)	Weight (grams)	Unspawned eggs		Potential egg production*	Estimated percentage unspawned
					Partially developed	Developed		
1	July 2	11.8	300	64	2,152	2,998	31,000	9.6
2	June 24	12.0	305	88	224	121	31,700	0.4
18	July 3	12.4	315	67	...	112	33,600	0.3
36	July 2	12.6	320	92	...	9,880	34,500	28.6
10	July 3	12.7	323	84	1,227	77	35,000	0.2
29	June 24	12.8	325	101	...	13,215	35,500	37.2
38	June 28	12.9	328	99	...	104	36,000	0.3
37	June 28	13.1	333	82	...	1,809	36,900	4.9
21	June 24	13.2	335	75	...	69	37,300	0.2
16	July 1	13.3	338	104	...	4,980	37,800	13.2
27	June 23	13.4	340	103	...	519	38,300	1.4
24	June 24	13.4	340	103	...	225	38,300	0.6
3	June 22	13.7	348	102	899	74	39,700	0.2
9	July 1	13.8	351	79	470	3,879	40,200	9.6
5	July 1	14.0	356	99	227	251	41,300	0.6
32	July 2	14.3	363	102	...	647	42,800	1.5
8	July 2	14.4	366	99	55	5	43,300	0.0
7	June 24	14.4	366	78	134	1,518	43,300	3.5
15	July 7	15.5	368	108	...	453	43,800	1.0
23	June 28	14.6	371	156	...	124	44,400	0.3

* Based on values obtained from curve projected in Figure 3.

Specimen number	Date of collection (1947)	Total length (inches)	Total length (mm.)	Weight (grams)	Unspawned eggs		Potential egg production*	Estimated percentage unspawned
					Partially developed	Developed		
34	June 29	14.7	373	131	...	6,392	45,000	14.2
33	June 24	14.7	373	118	...	6,386	45,000	14.2
22	June 29	14.8	376	119	...	222	45,500	0.5
19	July 2	14.9	378	104	...	148	46,000	0.3
13	June 23	15.0	381	117	...	470	46,500	1.0
4	July 3	15.0	381	144	...	366	46,500	0.8
20	June 30	15.0	381	145	...	271	46,500	0.6
40	June 29	15.1	384	161	...	820	47,100	1.7
17	July 2	15.6	396	166	...	322	49,800	0.6
39	June 28	15.6	396	126	...	354	49,800	0.7
6	July 2	15.7	399	112	33	48	50,400	0.0
31	June 29	15.9	404	166	...	790	51,600	1.5
26	July 1	15.9	404	153	...	92	51,600	0.1
28	July 3	16.3	414	186	...	2,113	54,000	3.9
25	June 28	16.4	417	203	...	10,584	54,500	19.4
12	June 26	16.7	424	116	...	980	56,500	1.7
14	July 2	16.8	427	123	...	1,397	57,100	2.4
35	June 28	16.8	427	201	...	11,101	57,100	19.4
30	July 2	17.0	432	192	...	1,806	58,400	3.1
11	June 20	18.1	460	236	47	205	67,000	0.3

* Based on values obtained from curve projected in Figure 3.

est egg production recorded, 24,021 eggs, was found in a 12.6-inch (320 mm.) female weighing 70 grams. The greatest recorded, 107,138 eggs, was found in a 21.1-inch (536 mm.) female weighing 316 grams. Using values obtained from the curve projected in Figure 3, we find that the mean egg production of females of average length (17.4 inches, 442 mm.) is 61,500 eggs. Mean egg production for successive one-inch size groups, estimated from the curve in Figure 3, is given in Table IV, together with the mean deviation for each of the groups.

PERCENTAGE OF UNSPAWNED EGGS

The egg production determined for the sea lamprey in the preceding section represents the basic reproductive potential of the species in the region studied. This potential is obviously never realized in nature. Many factors inherent in the organism itself and in its environment tend to nullify the potential, and the actual productivity of the species may be very low when these factors are considered. A preliminary experiment in the number of ammocoetes (larvae) produced per spawning female suggests that the larval hatch per number of eggs produced (and spawned) is quite small.

One of the inherent factors which may contribute to a low productivity is the percentage of ripe eggs remaining in the female after the spawning act is completed, that is, the number of unspawned eggs. Forty spent females were collected to determine this percentage. In order to avoid any doubt whether they had completed as much of their spawning act as they were destined to, only dead (30) or obviously dying (10) specimens were collected. Most collections were made in the deeper pools below spawning riffles or in sloughs into which the dying lampreys had drifted. The females obtained ranged from 11.8 inches (300 mm.) to 18.1 inches (460 mm.) in total length.

For ten specimens separate counts were made of the partially developed and fully developed eggs. For the remainder only the fully developed eggs were counted. These data are presented in Table V, with appropriate data on collection, size, and weight. The partially developed eggs were, as a rule, still trapped in the remnants of the ovary. Some fully developed eggs were found in like position, but when larger numbers of these were present, by far the bulk of them were loose in the coelom. The potential egg production of each female was determined from the curve projected in Figure 3. By means of this figure and the number of developed eggs retained in females the estimated percentage of unspawned eggs was computed (Table V). The partially developed eggs were not considered in estimating this percentage since their occurrence is variable with length. They are present in nominal numbers only in all but the very smallest size groups.

As a general rule, only a very small percentage of developed (mature) eggs remain unspawned; the estimated average percentage was 5.0 per cent. Among the specimens there are, however, several notable exceptions. For two individuals the estimated percentages of unspawned eggs were 28.6 and 37.2. Two others were identical in having an estimated 19.4 per cent of their eggs unspawned. All the females displaying a relatively high percentage of unspawned eggs were late migrants, appearing at the very end of the spawning season. Observations made upon late migrants of both sexes indicate a very low vitality at that time. I suspect that these specimens examined which contained a large number of unspawned eggs were unable to complete their spawning act before approaching death made them incapable of doing so. In view of this, the average percentage of 5.0 unspawned eggs is believed to represent the maximum average that occurs; indications are that this average would be lower if computed for specimens found spent nearer the beginning of the spawning season.

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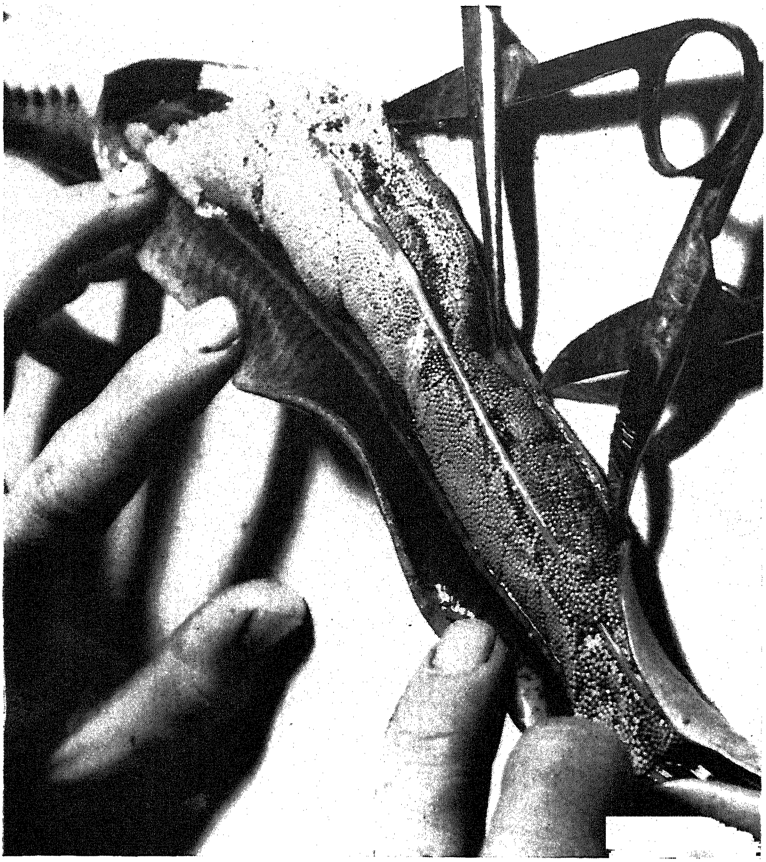

Dissection of a ripe female sea lamprey showing size, extent, and position of the ovary. Note the atrophied remains of the digestive tract lying on and within the ovary

THE COMPARATIVE HISTOLOGY OF THE ENTERON OF SOME AMERICAN TURTLES

GORDON W. BALLMER

WHILE engaged in the study of the various digestive enzymes of the turtle *Chrysemys picta marginata* and its histology I found no publication, except that of Claypole (1897), on the histology of the enteron in American turtles. Several European histologists have reported on the various European and African turtles. Rudolphi (1828) stated that there were no villi in the intestine of the turtle and that, instead, folds were present. Middledorpf (1846), Leydig (1853), Milne-Edwards (1860), Owen (1868), Machate (1879), Nussbaum (1882), Glinsky (1883), Sacchi (1886), Hoffman (1890), Giannelli and Giacomini (1896), and Oppel (1897) are the principal contributors to the literature concerning the histology of the enteron in turtles. Since the publication of Oppel's handbook of vertebrate microscopic anatomy no further record of enteron histology could be traced.

In her somewhat brief section on reptiles Miss Claypole mentions only the turtle *Chripenny picta.*[1] She placed particular emphasis on the mucosa and practically ignored the remaining portions of the enteron wall. Though her descriptions seem to fit the turtle *Chrysemys picta* in all details except two, they in no sense should have been construed as being representative of the turtles or even of the reptiles. Hoffman (1890), Nussbaum (1882), and Oppel (1897) have published comprehensive data concerning the histological details of the various Eurasian and African land and sea turtles to which, of course, American forms show marked similarity.

In this survey the entera of the following species will be described: *Amyda spinifera* (Trionychidae); *Sternotherus odoratus* (Kinosternidae); *Chrysemys picta marginata, Clemmys insculpta, Emys blandingii, Graptemys geographica,* and *Terrapene carolina* (Testudinidae).

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[1] *Chrysemys picta* in present classifications.

THE ESOPHAGUS

Milne-Edwards (1860) and other workers since his time have described papillae in the esophagus of various turtles. Papillae seem to be more prominent in the sea turtles than in the land-dwelling forms. I have been able to find them in *Amyda spinifera* and *Graptemys geographica* (Figs. 1–2). Unlike those in the sea turtles, they do not extend to the stomach in *Graptemys,* but, rather, become less frequent and are absent about halfway down the esophagus. In *Amyda,* on the other hand, they reach almost to the stomach.

In all the animals I examined the empty esophagus formed numerous longitudinal folds like those shown in cross section in Figure 3, and all reports in the literature agree with my findings. These folds extend all the way to the stomach and are very elastic, so that, when the esophagus is stretched in the swallowing of food, they may entirely disappear.

Histologically the esophagus is made up of the usual layers found in the higher vertebrates; they are as follows: mucosa, muscularis, and serosa. No muscularis mucosae is present, and hence there is no submucosa.

The mucosa of the esophagus is lined internally with a ciliated columnar epithelium containing numerous goblet cells. In the afterregion of the esophagus these cilia appear only in patches; before the stomach is reached they are no longer seen. Figure 5 is a cross-section view of the posterior esophagus in *Chrysemys picta marginata.* The nuclei of the ciliated cells are typically basal and vary morphologically from spherical to egg-shaped. In many cells, however, the nuclei are not basal but are centrally located, and this is true of tissues taken from nonfasted individuals. The goblet cells, as might be expected, also have basal nuclei, and their contents, when stained with thionin, take on a color characteristic of mucin.

Beneath these cells there is a thin basement membrane. Below this is a rather thick tunica propria consisting of loose connective tissue cells, lymphocytes, blood vessels, and fibrous elements. It is this extremely loosely constructed layer that takes up the slack during nonswallowing periods. Figure 7 shows the epithelium of goblet cells and ciliated cells. Figure 6 illustrates the loose tunica propria.

The muscularis consists of bands of smooth muscle running in both longitudinal and circular directions. In the anterior part of the esophagus the circular band is the more prominent. In the posterior part the longitudinal layer gradually becomes more prominent, so that by the time it reaches the stomach it is approximately equal in thickness to the circular band of smooth muscle and completely surrounds it.

The serosa envelops the muscularis and is composed mostly of connective tissue fibers, connective tissue cells, major blood vessels, and nerves. Surrounding the esophagus and the entire gut is a mesothelium.

On all points hitherto discussed virtually all observers are in agreement so far as they apply to the species investigated.

THE ESOPHAGEAL GLANDS

The question of the presence and function of esophageal glands has been a debatable one among students of the amphibia for over a century, and it still remains very much an enigma for some species. Some of the frogs are known to have esophageal glands very much like the cardiac and fundic glands found in mammals in the lower portion of the esophagus. In certain species, both American and foreign, it has been established that the posterior esophageal glands secrete a pepsin.

In different species of turtles there exists a wide variation in the glands. In *Trionyx chinensis* Hoffman (1890) found no glands at all in the esophagus. I have been unable to observe any in the comparable American form, *Amyda spinifera.* Oppel (1897), Giannelli and Giacomini (1896), and numerous others say that no gland formation is present in *Emys europaea.* In a comparable American form, *Emys blandingii,* I have found the beginnings of glandular formation. As seen in Figure 4, the infolding of the surface epithelium is partially completed, and the glands have taken on a semitubular alveolar shape. These glands are lined with goblet cells and ciliated cylindrical cells characteristic of the esophagus. They are simple in structure and have but one duct leading directly to the lumen of the esophagus. In areas in close proximity the glands may be separated only by a common basement membrane. Since the cells are typically like those of the esophageal lining both morphologically and in staining reactions, their function is probably the secretion of mucin. These glands occur in the posterior half of the esophagus. In *Sternotherus odoratus* I have been unable to find esophageal glands.

Hoffman (1890) describes compound tubular glands in the posterior region of *Chelodina longicollis* and likens them to the fundic glands of the stomach. This glandular area extends to the stomach. In the anterior part no glands were seen. In the same year Hoffman reported glands present in *Chelys fimbricata,* but in it they are simple and tubular, though they are very low. Similarly, he writes of finding large tubular glands in *Clemmys caspica.* I saw no semblance of glands in *Clemmys insculpta.*

Testudo graeca is a favorite reptile for zoological studies in Europe, and much has been written concerning it by the Europeans. Again we are told that glands are present in the caudal region, with an absence of glands anteriorly. Here they are simple and deeply tubular. They are lined with goblet cells and ciliated cells, both of which are cylindrical. Sacchi (1886) and Nussbaum (1882) describe the gland as being posterior. Oppel (1897), however, says that they begin in the middle area of the esophagus. Nussbaum believed them to be strict mucus secretors. In the lower half of *Terrapene carolina* we observe the rudiments of glandular formation. The epithelium, as shown in Figure 6, has commenced to involute to form a gland, but as yet the basement membrane has not done so. A similar condition exists in *Graptemys geographica* and the lizard *Anguis fragilis*.

Hoffman (1890) describes esophageal glands from the caudal region in *Chelemys victoria*. They are of the branched tubular type, though in a few they remain unbranched. They lie side by side, with little tunica propria intervening, and are lined with a ciliated epithelium. Their lumina open directly into that of the esophagus. Hoffman likens these glands to those in the proventriculus of the frog. Again no glands are to be found in the anterior esophagus.

In *Chrysemys picta marginata* esophageal glands occur in their greatest development. These compound tubular glands completely surround the lumen and virtually obliterate the tunica propria, as seen in Figures 8 and 10. They are present only in the middle third of the esophagus. They are lined with an epithelium consisting of a single layer of ciliated cylindrical cells alternating with cuboidal-cylindrical cells containing numerous zymogen granules in their apical regions (Fig. 11). As in the surface epithelium of the esophagus, the nuclei may or may not lie basally in the ciliated cells, but in the granule containing cells they are basal. It is these cells which make up the greater part of the gland. The granules stain with eosin, but not with thionin or methylene blue, and therefore I do not believe their function is the secreting of mucin. Preliminary tests indicate that the glands secrete a proteolytic enzyme.

The tips of the esophageal folds are lined with the usual columnar epithelium. With thionin (Figs. 9, 12), mucin appears darkly stained; the granules are clear.

In the American forms there apparently is an evolutionary sequence in the development of the esophageal gland, and *Chrysemys picta marginata* represents the greatest development. It is of interest to note that there seems to be no correlation between food habits, environmental factors, present systems of classifications, and the presence of the glands. Claypole (1897) makes no mention of glands in the esophagus of *Chripenny picta.*

STOMACH

Histologically the stomach may be divided into two portions, the fundic and the pyloric. The area of the fundic is by far the greater. The stomach in the turtle is very similar to that of the mammal in that it has rugae, a thick muscularis, and a highly glandular mucosa. Sphincters at either end of the stomach are generally not very pronounced in the resting condition. Recently fed turtles display, however, a sharp line of demarcation between the stomach and the intestine posteriorly and the esophagus anteriorly. The musk turtle perhaps best shows a wide variation in stomach form. When in a relaxed condition brought on by the absence of food, the stomach is discernible only by careful observation.

Histologically the stomach is made up of the layers common to the higher vertebrates, which are as follows: mucosa, muscularis mucosae, submucosa, muscularis, and serosa.

FUNDIC PORTION

The mucosa of the entire stomach is lined with a simple columnar epithelium. Many goblet cells are interspersed throughout. At gastric-pit openings the epithelium bends down and joins similar but somewhat cuboidal cells lining the necks of the fundic and pyloric glands. The nuclei, which are spherical, are basal. Figures 17, 18, and 19 illustrate the surface epithelium. There is a rather extensive tunica propria below the basement membrane. It is into this band of connective tissue cells and fibers that the deeply embedded glands reach virtually to the muscularis mucosae. This loose connective tissue layer is highly vascularized and is penetrated with numerous nerves and lymphocytes.

There is a thin band of somewhat ill defined longitudinal smooth muscle making up the muscularis mucosae. This is true both of the species described in the literature and of the specimens I examined.

The submucosa is a thin compact layer made up primarily of fibers, blood vessels, nerves, and connective tissue cells.

Two thick bands of smooth muscle, the inner of which is the circular layer and the outer of which is the longitudinal layer, surround the submucosa.

The serosa is very fibrous, with a scattering of connective tissue cells. Blood vessels and nerves are large and numerous. A mesothelium lines the serosa externally.

FUNDIC GLANDS

All workers, including myself, have observed that the fundic glands begin immediately posterior to the esophagus and that the upper ones consist of cuboidal cells with a clear cytoplasm. These first few simple tubular glands are similar to those in the cardiac region of the mammalian stomach and are believed to secrete mucus. Figure 13 is a cross section midway through four of these glands.

Immediately posterior to the glands mentioned above are the true fundic glands, about whose function no one is sure. They are made up of two types of cuboidal cells, clear and granular, as shown in Figures 14–16. Figures 18, 19, which are drawings taken from Oppel's handbook, illustrate the cellular detail of the stomach in *Emys europaea.* In Figure 16 the clear cells are shown grouped about the lumen and are larger than the granular cells of neighboring glands. The nuclei are basal and are triangular to semilunar in stained sections. In the granular cells the nuclei are spherical and occupy the center of the cell. In *Amyda spinifera,* the clear cells are much larger than the granular cells, as is shown in Figure 16. In the other turtles investigated the differences are not so striking. In longitudinal section a single gland appears to be made up of one type of cell, either clear or granular. This is true of all the specimens examined, though in some species there is a difference in the relative numbers of the two types of glands, *Amyda* having many more granular cell glands than *Chrysemys.* As a rule, each gland opens separately into the lumen of the stomach, but infrequently two glands may coalesce below the neck and enter the gastric pit through a common duct. In the fundic region the glands are separated from their neighbors by the tunica propria (Fig. 18).

Oppel (1896), who has described similar cells from the fundic region of *Thalassochelys caretta,* believes that, since they are morphologically like those in mammals, the clear cells are acid secretors. Sappey (1894) claims that the clear cells secrete mucus and makes no statement about the origin of the acid. It has been pretty well established that in mammals it is the parietal cell which secretes the stomach acid. The same holds true for the frog, though in it the parietal cell is rounded. In the mammals the parietal and chief or pepsin cells are in the same gland. This is not true of the turtle. Each gland below its neck seems to be made up of one type of cell, either clear or granular. Experiments are in progress to determine whether or not the acid-secreting cells are the clear ones. It is astonishing that Claypole (1897) was unable to detect any differences in the cellular composition of the glands.

PYLORIC PORTION

The pyloric portion is very similar to the fundic region except in the relative thickness of the muscularis and the presence of pyloric glands in the much thinner mucosa. The muscularis is much thicker here than in the fundic region. The pyloric glands are typical of those elsewhere in the higher vertebrates, where all workers are in agreement that they are shallower in the long dimension and, as we approach the pylorus, fewer. The epithelium of the glands appears to be a continuation of the surface epithelium, except in the lower region, where the cells are somewhat cuboidal. Their function is believed to be the production of mucus. This area is illustrated in Figures 17 and 19.

THE INTESTINE

The intestine in turtles, unlike that in mammals, is not subdivided into a duodenum, jejunum, ileum, and a colon. Morphologically and histologically, as far as the region of the cloaca, the structure of the intestine shows no change or variation in form. The intestine proper is one tube, with the same diameter and no lateral diverticula. No villi are present, and none have been reported in the literature as being present. Turtles do possess folds, however, as a means of increasing the surface area of the intestine. These range from eight in *Sternotherus* to around sixty in *Graptemys;* in cross section they can easily be mistaken for villi.

The usual layers of the intestinal wall in mammals are, in general, also present in the turtles (Figs. 20, 21).

The surface epithelium of the intestine is made up of a single layer of cylindrical cells, many of which are goblet cells. In all of them the nuclei are oval and basal. The substance in the goblet cells stains typically as mucin with both methylene blue and thionin, and they are therefore presumed to secrete mucin.

Beneath the basement membrane there is an extensive tunica propria, which makes up the greater portion of the intestinal fold. Figures 22 and 23 bring out in detail the structure of the epithelium and the tunica propria.

Giannelli and Giacomini (1896) describe the muscularis mucosae in *Testudo graeca* as being discontinuous. Machate (1879) says there is no muscularis mucosae in *Emys europaea.* I have found that only the box turtle, *Terrapene carolina,* has a muscularis mucosae. Hoffman (1890) describes the muscularis mucosae in both *Trionyx chinensis* and *Chelyemys victoria.*

Except in the four turtles mentioned above as having a muscularis mucosae, a submucosa is lacking in all forms so far investigated.

The muscularis is a continuation of the circular and longitudinal smooth muscle layers found elsewhere in the digestive tract. In such forms as *Sternotherus odoratus* and *Chrysemys picta marginata,* however, the outer longitudinal muscle layer is ill defined and at times is virtually nonexistent.

In addition to the usual fibers, connective tissue cells, blood vessels, and nerves that occur in the serosa, one finds in *Sternotherus odoratus* a narrow band of longitudinal smooth muscle lying in the center of the serosa. This species and the painted turtle, *Chrysemys,* do not have the outer muscle layer immediately beside the inner. There is a mesothelium around the serosa.

Except in the four species mentioned as possessing a muscularis mucosae, there are no crypts of Lieberkühn. Figure 21 shows the crypts in the box turtle, *Terrapene carolina.* The crypts are not as well developed as in the mammals and are the only glands to be found in the intestine proper of turtles. Near the cloaca, however, there are numerous shallow glands, whose function, it is believed, is to aid in respiration.

SUMMARY

The histology of the entera of some of the adult American turtles has been described. We have seen that there are differences among the several species and that most of them are confined to the mucosa. Claypole's description of the turtle, *Chripenny picta* (*Chrysemys picta*), was found to be inadequate for the fundic glands in the stomach and in its failure to make any mention of the esophageal glands.

It is of interest that, for the most part, the esophageal glands occur in the lower reaches of the esophagus. There seemingly is no correlation between their presence and food habits, length of neck, habitat, or known phylogenetic relationships. Similarly, the crypts of Lieberkühn display no correlation.

ACKNOWLEDGMENT

Finally, I wish to express my gratitude to Dr. A. E. Woodward for her direction of this research and for numerous helpful suggestions and to thank Dr. A. E. Woodhead, James Williams, and Perry M. Johnston for their assistance in the preparation of the photomicrographs and for useful suggestions.

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EXPLANATION OF PLATE I

FIG. 1. Cross section of the posterior esophagus of *Amyda spinifera*

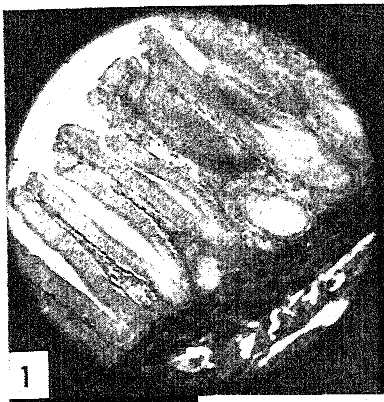
FIG. 2. Cross section through papillae in the lower esophagus of *Amyda spinifera*

FIG. 3. Cross section of the anterior esophagus of *Clemmys insculpta*

FIG. 4. Section of the lower esophagus of *Emys blandingii*

FIG. 5. Cross section of the lower esophagus of *Chrysemys picta marginata*

FIG. 6. Section of the lower esophagus of *Terrapene carolina*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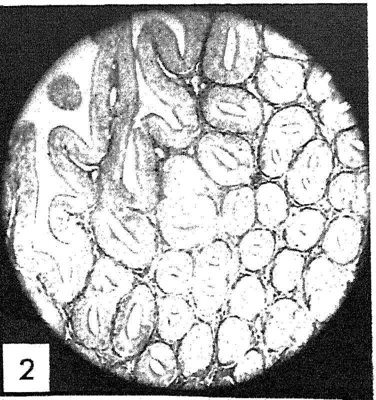
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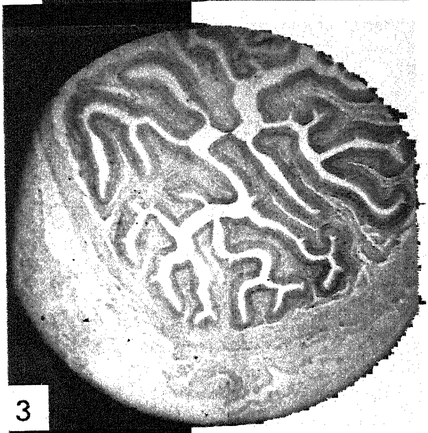
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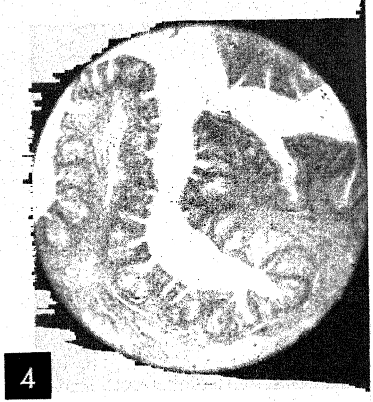
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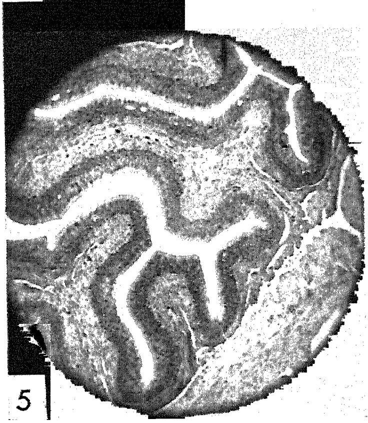
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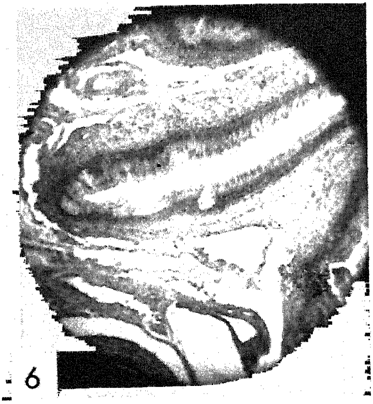
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EXPLANATION OF PLATE II

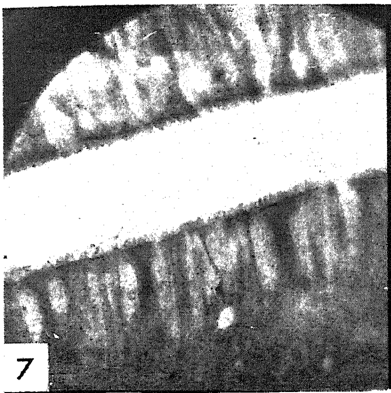
FIG. 7. The epithelium of the middle esophagus of *Clemmys insculpta,* showing both ciliated and goblet cells

FIG. 8. Esophageal glands from the middle esophagus of *Chrysemys picta marginata.* Note the duct system draining into the lumen at the lower right-hand corner

FIG. 9. Esophageal glands and the surface epithelium of *Chrysemys picta marginata.* Stained with thionin

FIG. 10. Esophageal glands from *Chrysemys picta marginata* as seen in longitudinal section

FIG. 11. Zymogen granules, as seen in longitudinal section, of the esophageal glands in *Chrysemys picta marginata.* Note the granules in the apical portion of the cells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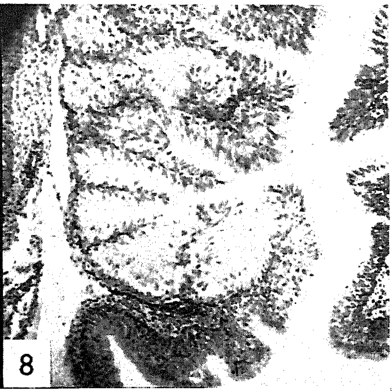
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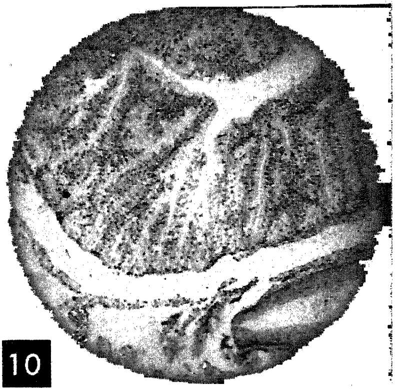
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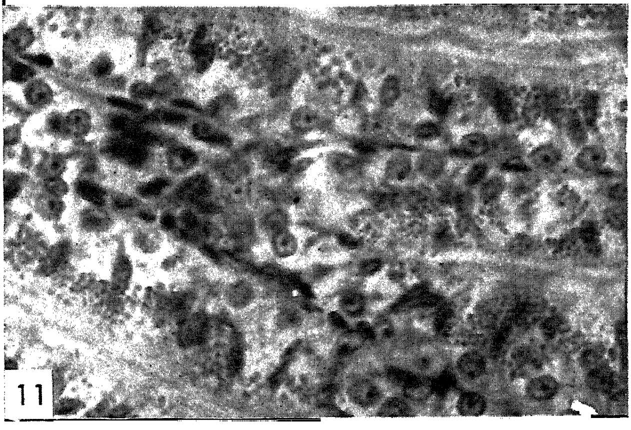
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EXPLANATION OF PLATE III

FIG. 12. Cross section of esophageal glands in *Chrysemys picta marginata.* Stained with thionin

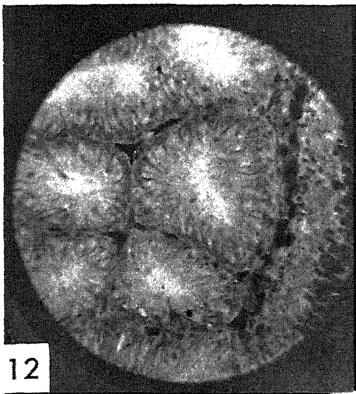
FIG. 13. Transverse section of "cardiac glands" from the extreme anterior portion of the stomach

FIG. 14. Fundic area of *Chrysemys picta marginata*

FIG. 15. Fundic glands from *Amyda spinifera* as seen in longitudinal section. The submucosa shows heavy pigmentation.

FIG. 16. Enlarged view of the fundic glands, showing the smaller dark-celled glands grouped about the larger clear-celled glands

FIG. 17. Longitudinal section of pyloric glands in *Chrysemys picta marginata*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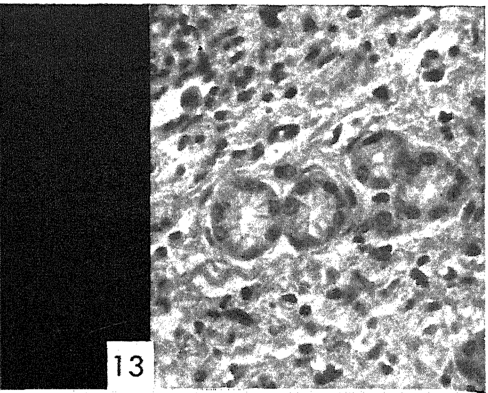
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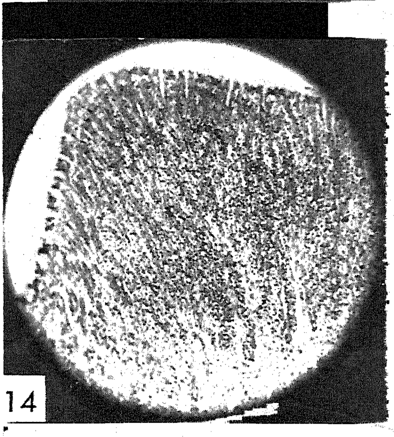
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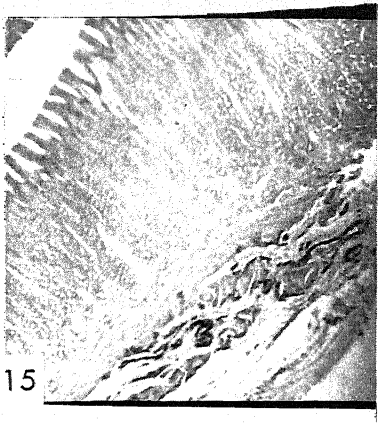
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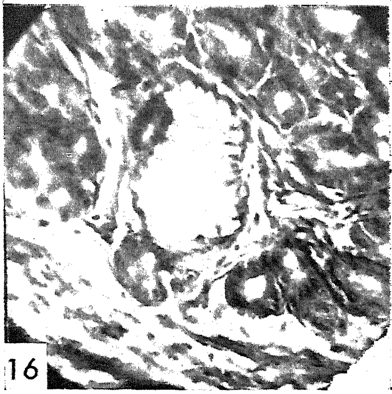
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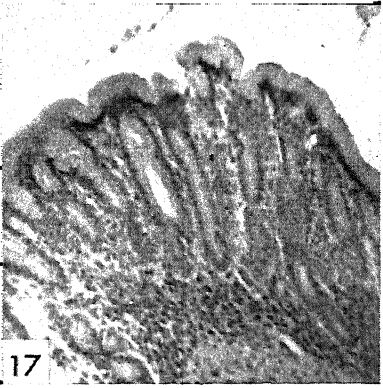
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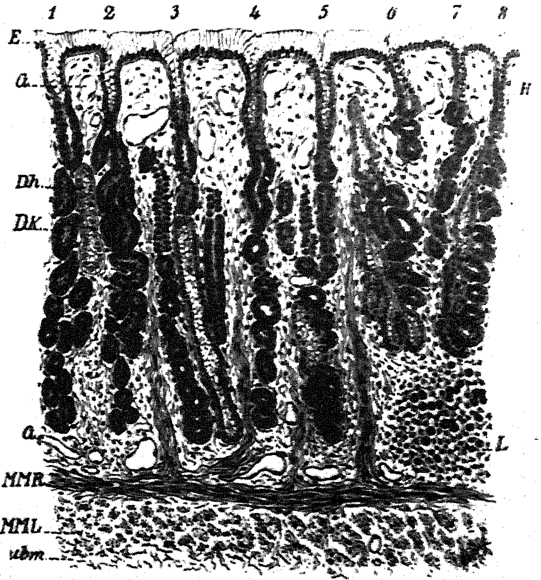

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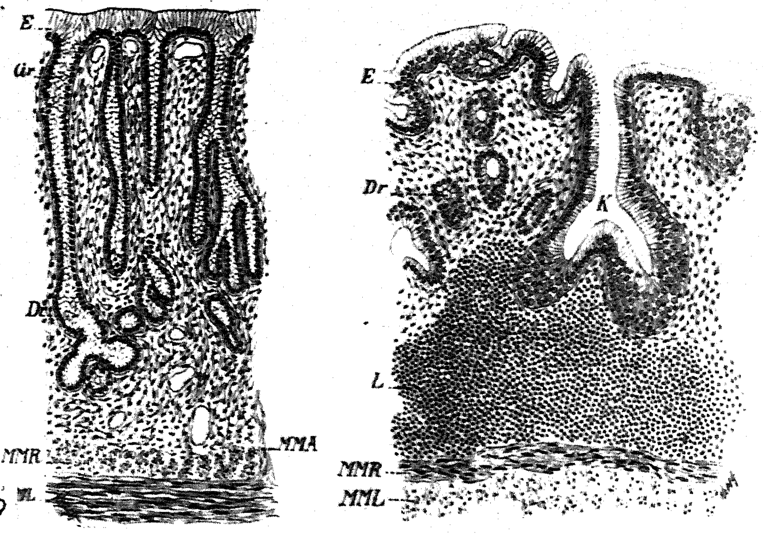

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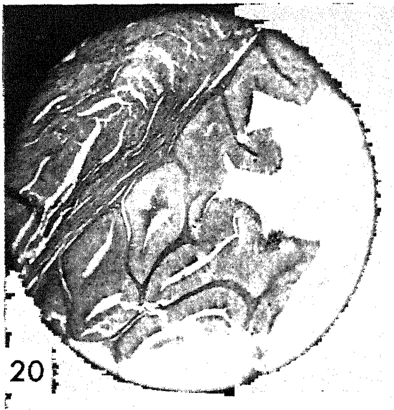
FIG. 18. The fundic area of *Emys europaea*
FIG. 19. The pyloric region of *Emys europaea*
(Drawings from Oppel, 1896–97)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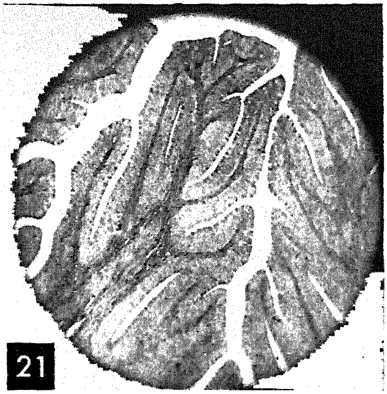
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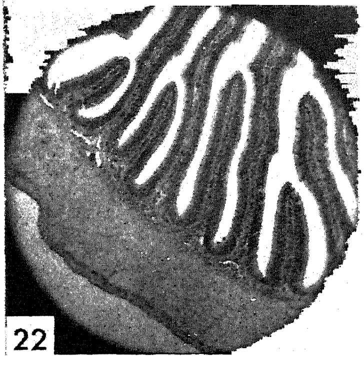
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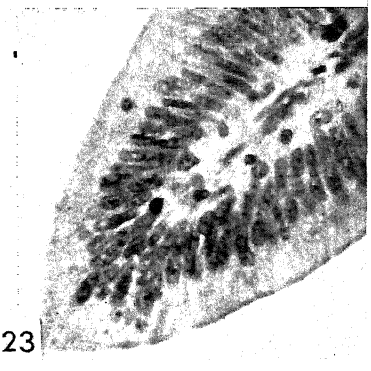
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FIG. 20. Longitudinal section of the intestine in *Amyda spinifera*
FIG. 21. Cross section of the intestine in *Terrapene carolina*
FIG. 22. Cross section of the intestine in *Chrysemys picta marginata*
FIG. 23. The tip of a fold in the intestine in *Sternotherus odoratus*

THE FAMILY BEMBECIDAE (HYMENOPTERA: SPHECOIDEA) IN MICHIGAN, WITH KEYS TO THE GENERA AND THE SPECIES OF THE STATE AND DISTRIBUTION RECORDS

ROBERT R. DREISBACH

THE Bembecidae, a family of beautifully maculated wasps, is easily distinguished from the other families of the Sphecoidea. It is separated from the bees by the *absence* of branched or plumoes hairs and by the *absence* of a thickened or flattened metatarsal joint of the hind legs; it is different from the other families by the combination of the following characters: middle tibiae with only one well-developed apical spur, eyes not emarginate, fore wings with three completely closed cubital cells, radial cell simple, not appendiculate, ocelli more or less aborted, and the large, free, triangularly elongated labrum, which extends well beyond the clypeus and is much longer than wide. The wings lie flat upon the back when the insect is at rest, and the second cubital cell receives both recurrent veins.

The genera discussed here belong exclusively to the Western Hemisphere, with the exception of the genus Bembex, which is world-wide in its distribution. These wasps are solitary and belong to the group known as Fossores or digger wasps, and both sexes have well-developed tarsal combs for burrowing in the sand. Though they are solitary, they often nest in colonies, and there may be several species in the colonies, yet each insect has its own nest.

This family is of some beneficial economic importance, since they prey upon such pests as house flies, stable flies, etc., which they use in provisioning their nests; since they are very plentiful in locations suitable for them, they must destroy great numbers of harmful insects.

Though at the present time we have records of only seven species which have been taken in the state, it is entirely possible that about ten other species will be discovered with further collecting, since the present known distribution of these species outside Michigan coincides with that of other species which are known from the state. It is unlikely, however, that any other genera will be found in the state. These ten species are placed in the key and marked with an asterisk if they are not at present known to inhabit Michigan. Comparing these seven species with other state records we find that the New York list (Leonard, 1928) contains seven, and that from North Carolina (Brimley, 1938) contains sixteen.

KEY TO THE MICHIGAN GENERA OF BEMBECIDAE

1. Anterior ocellus placed in a pit with the sides elevated .... *Stictiella* Parker
1. Fore ocellus not placed in a pit 2

2. Posterior surface of propodeum concave, with its posterior angles prolonged and wedge-shaped .... *Bicyrtes* Lepeletier
2. Posterior angles of propodeum not prolonged and not wedge-shaped 3

3. Mandibles not dentate; apical third of marginal cell not confluent with the anterior edge of wing but radiating away from it .... *Microbembex* Patton
3. Mandibles dentate; anterior edge of marginal cell confluent with the anterior edge of wing .... *Bembex Fabricius*

KEY TO THE SPECIES OF THE GENUS *BEMBEX* FABRICIUS

1. Females, twelve antennal segments and six abdominal segments 2
1. Males, thirteen antennal segments and seven abdominal segments 8

2. Fasciae on tergites beyond the first continuous, not interrupted, the first may be continuous or interrupted 5
2. Fasciae on tergites all interrupted in the middle, none continuous 3

3. No yellow markings whatever on thorax, head, or face, except a narrow yellowish line on upper posterior orbits; the large whitish spots of second tergite enclose a small, elongate black line, and the ones on third tergite are U-shaped, these spots after the second tergite become increasingly narrow; no maculations on fifth or sixth tergite; sixth tergite strongly longitudinally wrinkled; a small, isolated yellowish spot on the posterior outer corners of second and third ventrites, which reaches neither the sides nor the posterior edge of ventrites .... *belfragei* Cresson
3. Clypeus, face, and part of front white or yellowish; fascia on fifth tergite, sixth tergite not wrinkled; spots on ventrites reach the edge 4

4. Pubescence on head and thorax, especially on sides, long and hairy; middle tibial spur one half as long as or longer than its metatarsal joint; one or two yellowish spots on mesopleura; a yellow spot below on anterior coxae, which, however, may be absent, and the femora are more or less greenish white .... *amoena* Handlirsch*
4. Pubescence on head and thorax normal, middle tibial spur less than one half as long as its metatarsal joint; no yellow spots on mesopleura; fore coxae black and its femur black below on its basal half .... *spinolae* Lepeletier

5. All the fasciae on tergites continuous 6
5. All the fasciae on the tergites continuous except on the first, where the fascia is interrupted in the middle except one case 7

6. Continuous greenish-white bands on posterior edges of mesonotum, scutellum, postscutellum, and dorsal edge of propodeum; no maculations on dorsal edge of mesonotum, or on plate under rear wings, and only a narrow whitish line under tegulae; fore tibiae with a black mark on outer and ventral surface; wing hyaline with no trace of color .... *pruinosa* Fox

6. Continuous yellowish lines located on the same edges as the greenish-white bands in the preceding rubric; a yellow line on dorsal edge of mesonotum, touching the fasciae on scutellum and extending forward from this mark and ending just short of touching the pronotum; plate under rear wings with a broad yellow maculation, and a broader maculation under tegulae than in last species; fore tibiae with a black mark on ventral surface only, none on outside; two black spots enclosed within the yellow maculations on second and third tergites; only the basal slope and a very small part of dorsal part of first tergite black, but the posterior border is black, only the very narrow posterior edges of second and third tergites black besides the two enclosed spots; fourth and fifth tergites completely yellow and sixth entirely black in normal position, although two black spots similar to those on second and third tergites just visible under the telescoped edge; color bright yellow where the preceding species is greenish white, and this color covers almost the whole abdomen; wings with a very noticeable cloud over the center; bands on abdomen with a depression on each side in front, and they do not touch front of tergite and only touch the posterior edge at the sides .... *nubilipennis* Cresson*

7. Fascia on first tergite continuous; lateral lines and a pair of discal marks on mesonotum; posterior surface of propodeum not maculated (except maybe the lateral angles) .... *sayi* Cresson*

7. Some maculations on mesonotum, dorsum, and posterior surface of propodeum, except that one or two of these surfaces may be without maculations .... *primaestate* Johnson and Rohwer

8. Middle femur not serrate or dentate beneath, smooth; seventh sternite ending in a spine, no process on second sternite; color on abdomen pale, whitish, but light yellow on head and thorax, with two short discal marks on mesonotum .... *pruinosa* Fox

8. Middle femur serrate or dentate, although there may be only a few teeth near distal end 9

9. Process on sixth sternite a transverse ridge, not sharply pointed but slightly curved on each side of middle; second sternite with a large medial, laterally compressed, slightly hooked process; the seventh sternite a small median, posterior process, from which a pair of inconspicuous carinae diverge basally .... *belfragei* Cresson

9. Process on sixth sternite not as above, nor are those on second and seventh sternites as above 10

10. Process on sixth sternite prominent, its ventral surface flattened and bifurcate at tip 11

10. Process on sixth sternite not bifurcate 12

11. Spur on middle tibiae reaching to or beyond the middle of its metatarsal joint *amoena* Handlirsch*

11. Spur on middle tibiae not reaching to the middle of its metatarsal joint *sayi* Cresson*

12. Process on sixth sternite prominent, its ventral surface flattened, bluntly pointed; a pair of lateral processes on same sternite; generally well maculated .... *nubilipennis* Cresson*
12. Process on sixth sternite not as above, and without lateral processes on the same sternite 13

13. Sides of propodeum and thorax with conspicuous maculations, but scutellum without lateral spots .... *primaestate* Johnson and Rohwer*
13. Sides of propodeum and thorax (excluding pronotum) black, not maculated except that there may be small spots on mesopleura 14

14. Fasciae on tergites usually, though not always, interrupted in the middle, and light yellow or greenish white in color; last tergite black; a strong process on both second and sixth tergites, the latter flat on ventral surface, the flat part triangular and ending in a point .... *spinolae* Lepeletier
14. Fasciae on tergites relatively broad and of a greenish-yellow color, all but the first continuous; last tergite maculated; process on sixth sternite narrow and sharply pointed .... *primaestate* Johnson and Rohwer*

KEY TO THE GENUS *STICTIELLA* PARKER

1. Males, thirteen antennal segments and seven visible abdominal segments 2
1. Females, twelve antennal segments and six visible abdominal segments 7

2. Second sternite without a tubercule 3
2. Second sternite tuberculate 5

3. First sternite with a tubercule, which is ridged on ventral surface; middle femur smooth beneath .... *pictifrons* (Smith)*
3. Middle femur serrate or dentate beneath 4

4. Anterior tarsi dilated and flattened; apical segments of all tarsi black; continuous fasciae on sternites; wings hyaline .... *formosa* Cresson*
4. Tarsi normal; no continuous fasciae on sternites, but with lateral spots; wings infumated .... *serrata* Handlirsch*

5. Middle femur smooth beneath; head narrower than thorax: second cubital cell on marginal vein about one half its width on the cubital vein *emarginata* Cresson
5. Middle femur dentate or serrate beneath; head normal and as wide as thorax; apical segments of tarsi black, anterior pair dilated 6

6. A large species, 18–20 mm. in length; fasciae on tergites broad and continuous except on the first, where the fascia is interrupted in the middle; fascia on second tergite enclosing a pair of black spots, one on each side of tergite; fasciae on sternites continuous or narrow interrupted .. *speciosa* (Cresson)*
6. A smaller species, 15 mm. long; fasciae on tergite one or on one to three interrupted in the middle, thus leaving on one or more of the tergites a pair of yellow discal spots; yellow on sternites in the form of yellow spots *spinifera* (Mickel)*

7. Pulvilli indistinct; mesonotum may or may not have discal marks; mesopleura without maculations; fasciae widely interrupted in middle on first tergite; fasciae yellow; wings infumated .... *serrata* (Handlirsch)*
7. Pulvilli distinct 8

8. Mesonotum without discal marks; head narrower than thorax; length of second cubital cell on the marginal vein one half its length on the cubitus *emarginata* (Cresson)
8. Mesonotum with discal marks, more or less well developed 9

9. Discal marks on mesonotum consisting of a pair of irregular spots or of a pair of unbroken lines; scutellum with a continuous fascia, rarely broken on median line; fascia on first tergite deeply emarginate on anterior border at midline or entirely cut, leaving a posterior discal spot . *pictifrons* (Smith)*
9. Discal marks on mesonotum in the form of a U, either broken, interrupted medially, or broken into lines or spots; second sternite more or less black, not entirely yellow 10

10. Tergites without posterior black border; posterior tarsi, except basal joint, dusky above .... *speciosa* Cresson*
10. Tergites with a posterior black border; posterior tarsi yellow *formosa* (Cresson)*

KEY TO THE GENUS *BICYRTES* LEPELETIER

1. Males, thirteen antennal joints and seven visible abdominal segments 2
1. Females, twelve antennal joints and six visible abdominal segments 5

2. Posterior coxae with a tooth on inner distal end .... *fodiens* (Handlirsch)*
2. Posterior coxae without such a tooth 3

3. Middle femur with a tooth at base below; last tergite black, fasciae on tergites narrow .... *ventralis* (Say)
3. Middle femur without a tooth at base below 4

4. Fasciae on tergites interrupted medially, the one on sixth reduced to widely separated spots; no fascia on posterior border of scutellum, mesopleura more or less conspicuously maculated .... *quadrifasciatus* (Say)
4. Fasciae on tergites interrupted medially, but not reduced in width at the center, and the fascia on sixth tergite not reduced to widely separated spots; fascia on anterior border of scutellum, but the mesopleura not maculated; legs black and ferrugineous maculations deep yellow, frequently with a dash of ferrugineous .... *canoptera* Handlirsch*

5. Posterior coxae with a tooth on inner distal margin .... *fodiens* Handlirsch*
5. Posterior coxae without such a tooth 6

6. Last tergite with pygidial area and lateral ridges, although sometimes weakly developed; mesonotum without discal marks; mesopleura generally black; fasciae on tergites interrupted medially, those on apical tergites shortened or narrowed laterally, with sixth tergite black ...... *canoptera* Handlirsch*
6. Last tergite without pygidial area and without lateral ridges; last tergite black 7

7. Mesopleura black; fascia on fifth tergite no more interrupted than on other tergites; fascia on first tergite not so strong as on the next .... *ventralis* (Say)
7. Mesopleura maculated, more or less with yellow; fascia on fifth tergite much more widely interrupted medially than that on the first or it may be lacking; discal marks on mesonotum lacking or reduced to narrow lines *quadrifasciatus* (Say)

The genus *Microbembex Patton* is represented in the state by one species, *monodonta* (Say), and no other species of the genus is likely to be found in it.

The distribution records listed below are taken from specimens in the collections of the University of Michigan and the writer, with a few from various other collections. U.P. signifies Upper Peninsula; L.P., Lower Peninsula.

ANNOTATED LIST OF THE MICHIGAN SPECIES

BEMBEX BELFRAGEI Cresson. — Newago Co., August 1, 1943, one specimen in the collection of the writer; a very rare species.

BEMBEX PRUINOSA Fox. — Wayne Co., September 5, and Berrien Co., August 5.

BEMBEX SPINOLAE Lepeletier. — Dates of capture, July 2 to September 28. U.P.: Keweenaw, Houghton, Ontonagan, Iron, Dickinson, Marquette, Alger, Schoolcraft, Luce, Chippewa, and Mackinac counties. L.P.: Emmet, Cheboygan, Presque Isle, Charlevoix, Leelanau, Otsego, Montmorency, Benzie, Kalkaska, Crawford, Manistee, Iosco, Mason, Clare, Gladwin, Oceana, Newaygo, Isabella, Midland, Bay, Huron, Muskegon, Gratiot, Saginaw, Genesee, Lapeer, Ingham, Livingston, Oakland, Kalamazoo, Washtenaw, Wayne, Berrien, and St. Joseph counties. This is one of the most common insects of Michigan, as the records from forty-seven counties show.

BICYRTES QUADRIFASCIATUS (Say). — Dates of capture, July 20 to September 2. L.P.: Benzie, Manistee, Wexford, Missaukee, Iosco, Mason, Lake, Osceola, Arenac, Oceana, Newaygo, Mecosta, Midland, Huron, Muskegon, Kent, Gratiot, Saginaw, Tuscola, Ottawa, Lapeer, Allegan, Ingham, Livingston (George Reserve), Van Buren, Washtenaw, Wayne, and Berrien counties. The twenty-eight counties represented show that this species is very common, but it is strange that there are no records from the Upper Peninsula, since it should certainly be found there.

BICYRTES VENTRALIS (Say). — Dates of capture, July 7 to September 14. Houghton, Ontonagan, Dickinson, Marquette, Alger, Chippewa, and Mackinac counties. L.P.: Emmet, Cheboygan, Charlevoix, Leelanau, Antrim, Otsego, Montmorency, Kalkaska, Crawford, Alcona, Manistee, Wexford, Roscommon, Iosco, Mason, Lake, Osceola, Gladwin, Arenac, Oceana, Newaygo, Midland, Huron, Muskegon, Kent, Montcalm, Gratiot, Ottawa, Lapeer, Ingham, Livingston (George

Reserve), Oakland, Van Buren, Kalamazoo, Washtenaw, Wayne, Berrien, and St. Joseph counties, a total of forty-five counties.

MICROBEMBEX MONODONTA (Say). — Dates of capture, July 18 to August 30. U.P.: Alger. L.P.: Charlevoix, Leelanau, Mason, Osceola, Oceana, Midland, Bay, Huron, Muskegon, Saginaw, Genessee, Allegan, Ingham, Livingston (George Reserve), Oakland, Van Buren, Washtenaw, Wayne, Berrien, and St. Joseph counties, a total of twenty-four counties.

STICTIELLA EMARGINATA (Cresson). — Marquette County, July 10, 1937; a very rare species.

MIDLAND, MICHIGAN

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THE EFFECTS OF ETHYNYL TESTOSTERONE AND PROGYNON ON THE REGENERATION OF THE GONOPODIUM OF NORMAL AND CASTRATED MALES OF *LEBISTES RETICULATUS*

ARTHUR F. HOPPER

I. Introduction

THE Poeciliidae are a family of viviparous fish in which the anal fin of the male develops into a complex structure that functions as an intromittent organ and is known as the gonopodium. Turner (1947), by means of castration experiments, showed that the differentiation of the gonopodium was dependent upon the testicular hormone, and Turner (1941, 1942) and Grobstein (1942, 1948) have reported that the anal fins of females treated with androgenic hormones may be stimulated to develop into gonopodial-like structures. The anal fins of females will regenerate completely in the forms so far investigated, but the regeneration of the anal fins of mature males differs in different species. Grobstein (1947) stated that the gonopodium of mature males of *Platypoecilus maculatus* regenerated abortively and atypically and that the loss of regenerative capacity was most noticeable in the more peripheral rays of the fin. Turner (1947) also noted a loss of regenerative capacity in the gonopodium of mature males of *Gambusia affinis*, but in this species the loss is most evident in the central rays of the fin, the ones which originally showed the greatest morphogenic response to the androgenic stimulation from the developing testis. Hopper (1949) found that the gonopodium of mature males of *Lebistes reticulatus* regenerated completely and typically.

The present paper reports a group of experiments on males of *Lebistes reticulatus* through which an attempt has been made to analyze further the mechanisms underlying the hormonal control of anal-fin differentiation. The fish used in these experiments were obtained from a stock kept in the laboratory of Dr. C. L. Turner at Northwestern University. The hormone preparations employed were ethynyl testosterone, available in tablet form as Pranone, and theelol and theelin, available in tablet form as Progynon. Both are commercial preparations of the Schering Corporation.

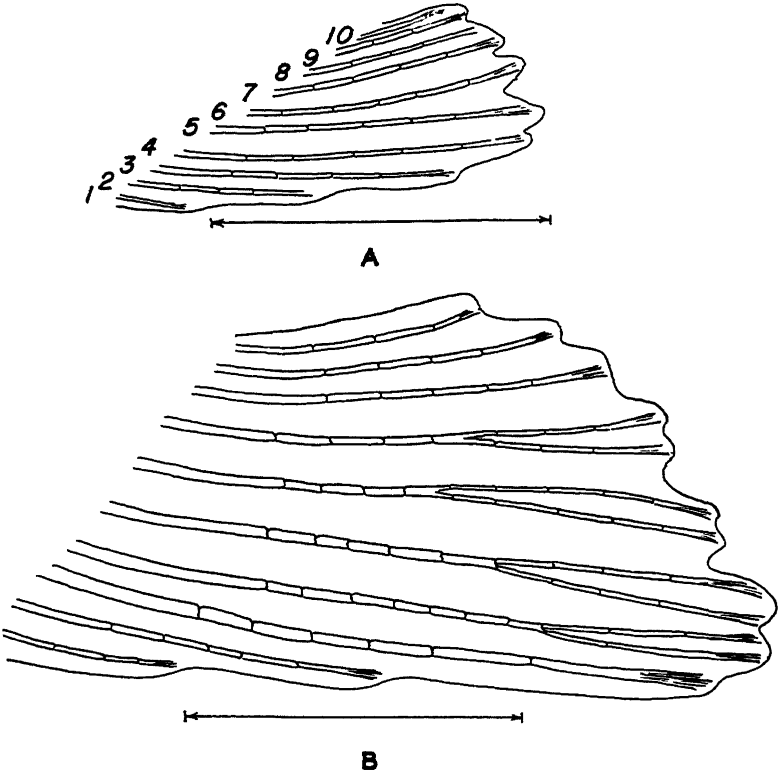

FIG. 1. A. Anal fin of a one-day-old fish. B. Anal fin of a young female (All drawings of fins are by camera lucida. The lines between arrowheads represent 1 mm.)

II. EXPERIMENTAL RESULTS

Development in the Anal Fin

At birth the anal fins of males and females are indistinguishable from each other. They are supported by 8 segmented and 2 unsegmented rays, which we may number from 1 to 10 from the cranial to the caudal border of the fin. Each ray consists of 2 mirror image components lying side by side. All rays are unbranched, and the fin has a lobe-shaped appearance, with rays 4, 5, and 6 being the longest (Fig. 1A). The rays of the anal fins of females continue to grow and add new segments at a relatively constant slow rate throughout the lifetime of the fish. The shape of the anal fin of the adult female is approximately the same as that of the juvenile fish (Fig. 1B). The development of the male anal fin for the first 60–90 days after birth parallels that of the female. However, fusion of the basal segments of the fin rays, which continues throughout the lifetime of the female, is restricted to a single pair of segments in the male.

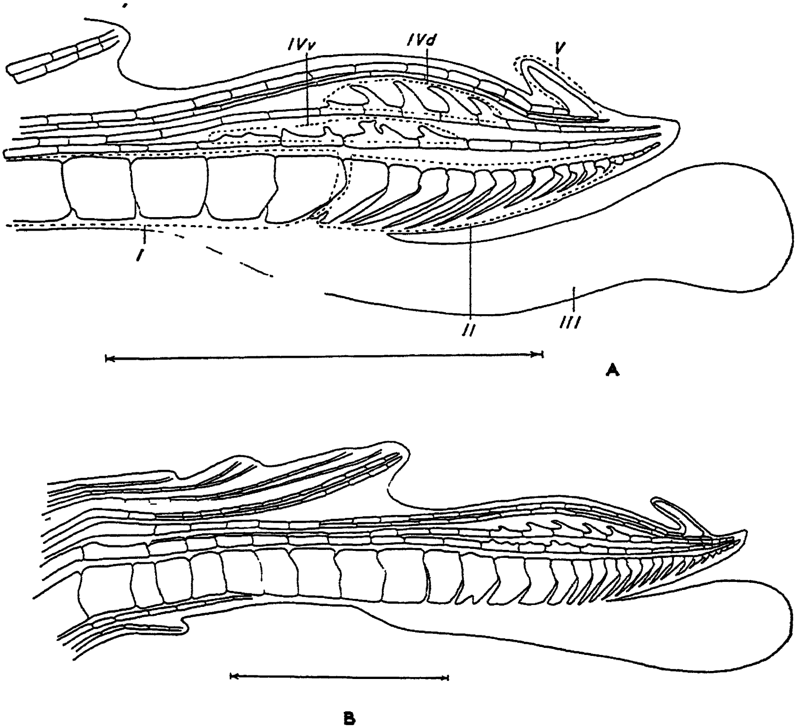

FIGURE 2

A. Distal portion of the gonopodium of a mature male. Differentiation areas are indicated by Roman numerals

B. Typical gonopodium regenerated after anal-fin excision in a normal mature male

Commencing 60–90 days after birth, at the 9-segment stage (9 segments in ray 3), elongation of rays 3, 4, and 5 and a thickening of the basal portions of rays 3 and 4 mark the beginning of gonopod morphogenesis. During this morphogenesis the growth and segmentation of rays 3, 4, and 5 greatly exceed those of the other rays, and the deposition of characteristic bony structures in certain areas of the 3–4–5-ray complex results in a definitive anal fin, which is considerably different from that of the female (Fig. 2A). Six differentiation areas have been designated in *Lebistes*. They appear in a regular time and space pattern and may be numbered according to their time of appearance in the normal morphogenesis of the gonopodium. Figure 3B graphs the rate of addition of new

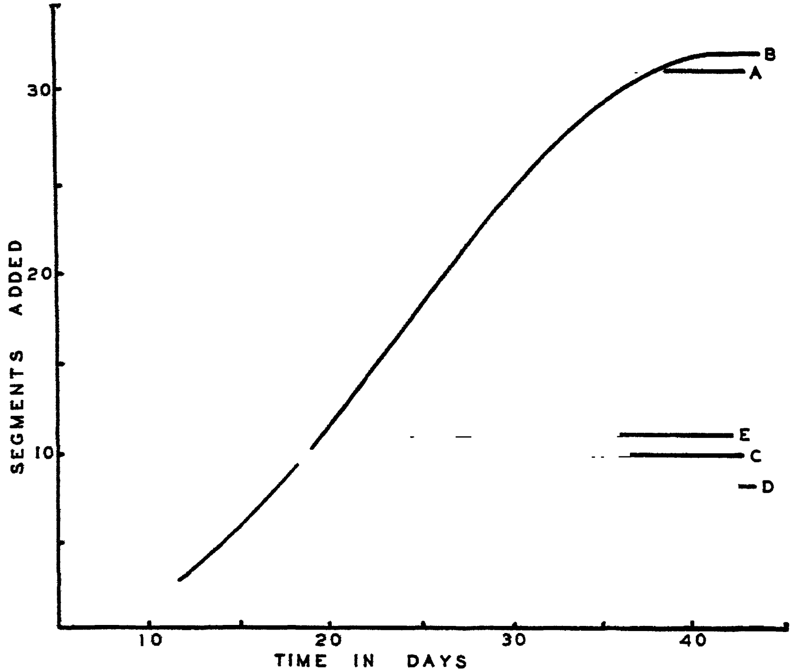

FIG. 3. Graph of segmentation rate of the third ray during anal-fin regeneration. Zero days represent times of anal-fin excision. A. Normal morphogenesis, showing curve starting sixty days after birth. B. Regeneration in a normal mature male. C. Regeneration in a castrated male. D. Regeneration in a normal male treated with Progynon. E. Regeneration in a normal male treated with Progynon

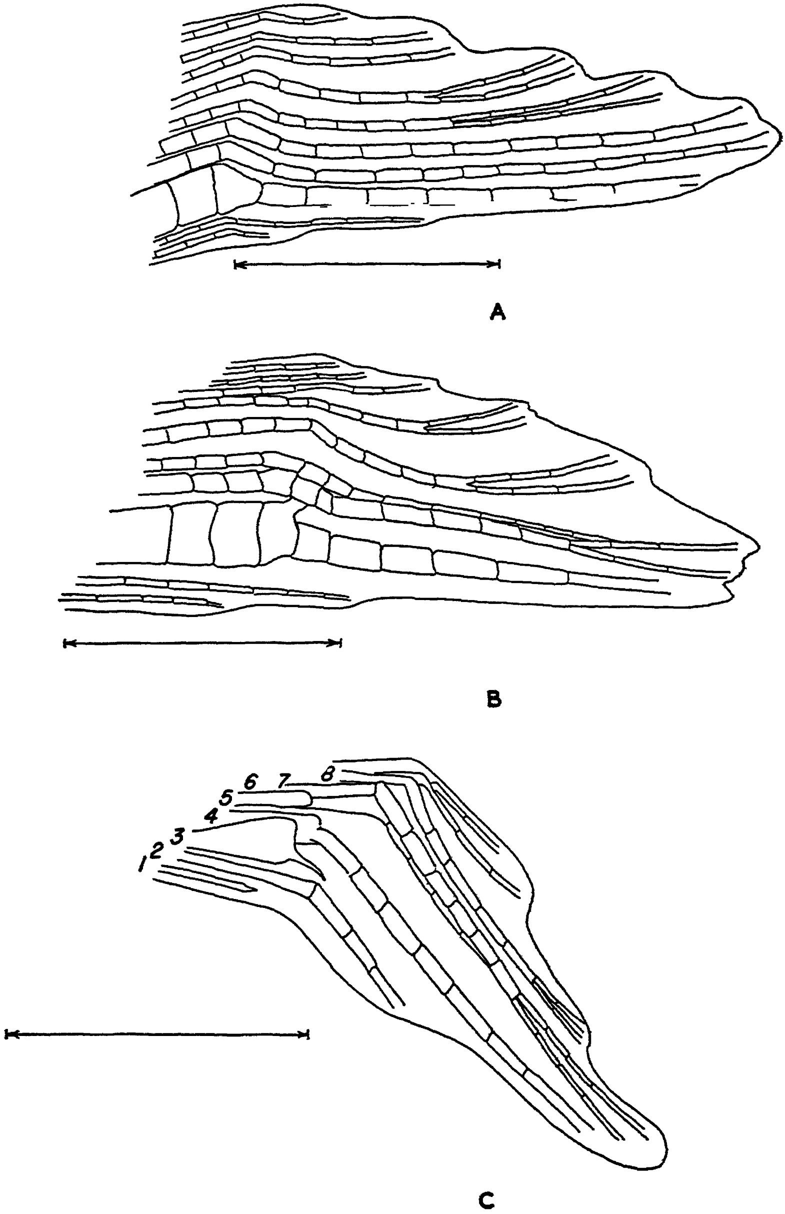

FIG. 4 A–C. Anal fins regenerated by castrated males

segments to the third ray during gonopod morphogenesis, when approximately one new segment is formed each day.

Regeneration in Normal and Castrated Males

If the anal fins of mature males are cut back to the level of the third segment of the third ray, an entirely normal gonopodium will regenerate in approximately 40 days. All rays regenerate; the differentiation areas appear in the same time and space pattern as during normal morphogenesis and are completely typical, and the rate of segmentation of the regen-

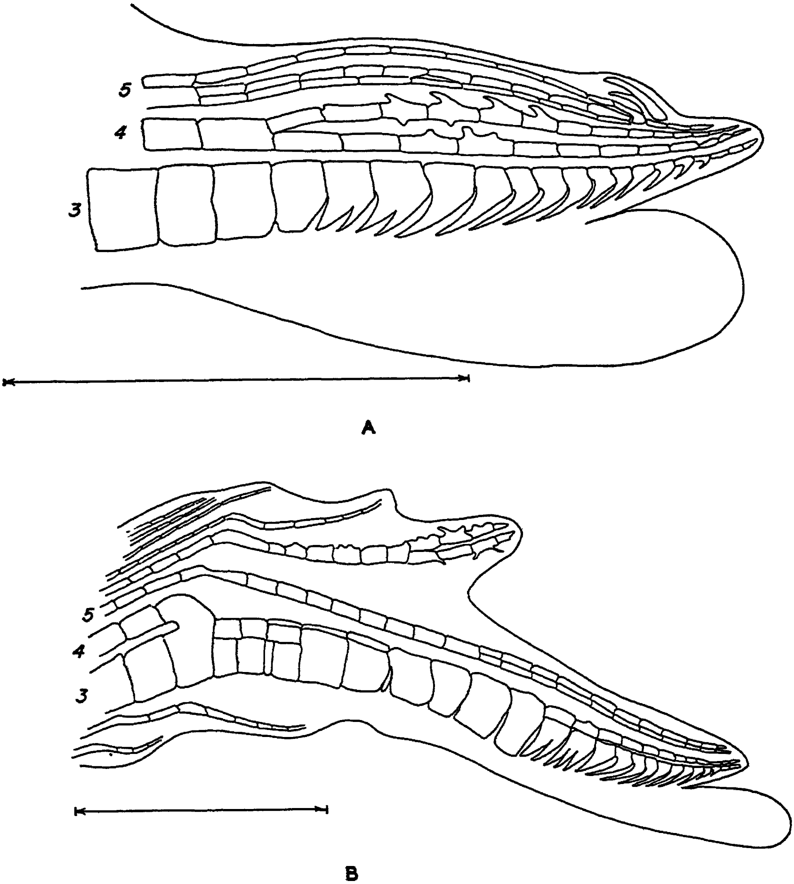

FIG. 5A–B. Gonopodia regenerated by normal males treated with ethynyl testosterone

erating rays is the same as that during normal morphogenesis. Figure 2 B represents a gonopod regenerated after excision of the anal fin of a mature male.

Castration operations were performed on 20 males and, after the

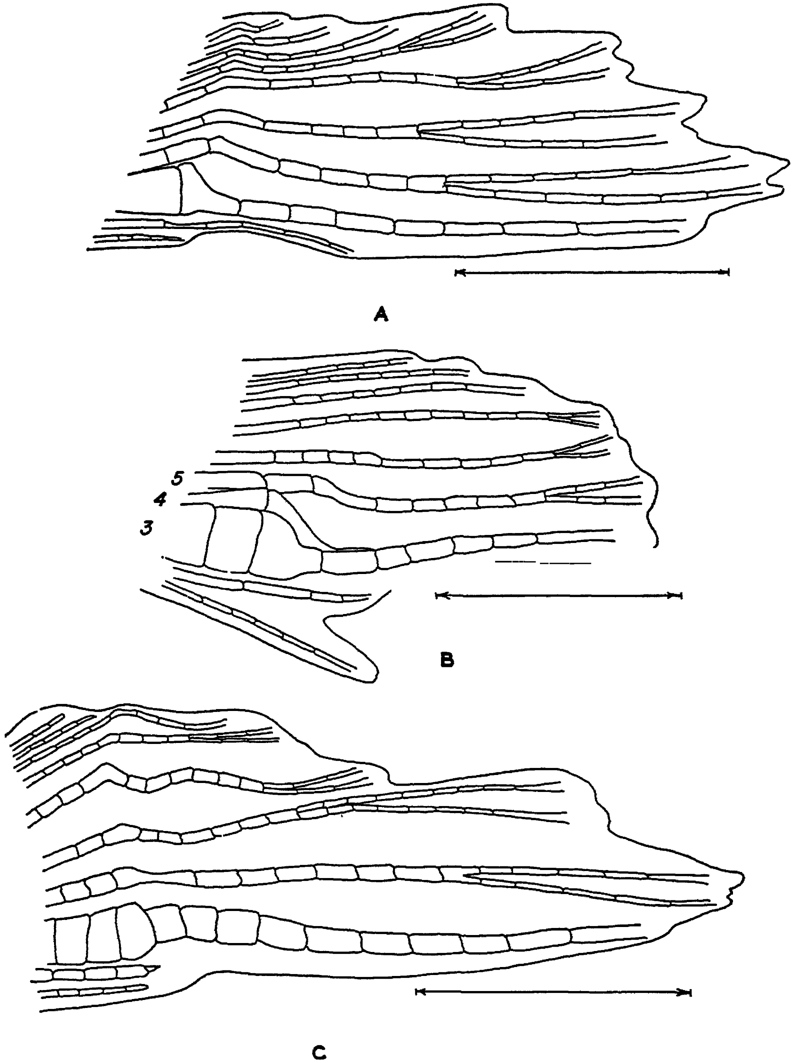

FIGURE 6

A–B. Anal fins regenerated by castrated males treated with Progynon
C. Anal fin regenerated by a normal male treated with Progynon

wound had healed, the anal fins were cut back. At the conclusion of the experiment autopsies showed that 14 of these males had been incompletely castrated and had regenerated all or part of the testis. About 6 or 7 days after excision of the fin a regeneration blastema is formed and new rays are evident in this blastema about 10 days after excision. Segmentation proceeds rapidly for the next 10 days and then tapers off after the third ray has formed approximately 10 segments (Fig. 3C). Incompletely castrated males regenerated typical gonopodia. Not all 10 rays of the anal fin regenerated in all males on which castration operations had been performed. Five of the incompletely castrated males regenerated fins with one or more rays lacking, and 3 of the 6 completely castrated males formed fins with missing rays. Two completely castrated males regenerated anal fins with 2 of the rays of the 3–4–5-ray complex lacking. Regeneration of the anal fins of completely castrated males did not in any case result in the formation of a gonopodium-like anal fin. The regenerated fin resembled that of a female (Fig. 4A, B, C), and the number of segments in the fin rays was similar to the number formed in comparable rays of the female fin. Figure 4C represents the anal fin of a castrated male in which rays 1, 3, and 5 failed to regrow and ray 6 fused with ray 7.

Hormone Treatment of Castrated Males

Five castrated males with gonopodia excised were placed in a concentration of 1 mg. of Progynon to 100,000 c.c. of tap water and 3 were placed in a concentration of 1 to 500,000. All 8 males regenerated anal fins in the female pattern, in which ray segmentation and growth rates were typically female in character (Fig. 3D). The appearance of new rays in the regenerating fins was delayed, in comparison with normal regeneration, and in one fish new rays were not evident until 20 days after fin excision. Three of the fish failed to regenerate one or more rays of the fin (Fig. 6A, B), a result mentioned above as characteristic of the regeneration process in castrated males.

If castrated males in which the anal fins have been cut back are treated with a concentration of 1 to 1,000,000 parts of ethynyl testosterone during anal-fin regeneration, all the rays will regenerate, but with the concentration employed in this experiment not all the differentiation areas are formed, and segmentation is not so rapid as that during normal morphogenesis. The slow rate of regeneration and the failure of formation of some of the terminal differentiation areas indicate that this concentration is below optimum for induction of typical gonopodia.

Hormone Treatment of Normal Males

Three normal males were placed in a concentration of 1 to 1,000,000 parts of ethynyl testosterone 10 days after anal-fin excision. Segmentation continued rapidly in the regenerating fin for the next 20 days until the third ray had formed 25 segments. The appearance of a regenerated fin at the completion of this experiment is shown in Figure 5A. In addition to the fact that the 3–4–5-ray complex is slightly shorter than normal, certain other abnormalities are apparent — double spines on ray 3 and secondary bifurcation of the ventral branch of ray 5. Figure 5B shows the regenerated anal fin of another male from this experiment in which an even greater departure from the normal is evident. Particularly noticeable is the absence of area V on the end of ray 5, apparently owing to a premature termination of growth in the regenerating fin. In the three fish used in this experiment all 10 rays of the gonopodium regenerated.

Four normal males were placed in a concentration of 1 to 100,000 Progynon 10 days after gonopod excision. Only one of these males regenerated a normal gonopodium, and even in it the rate of ray segmentation during regeneration was considerably slower than that observed during normal gonopod regeneration, and the number of segments in the third ray, 25, was less than that normally formed in the typical gonopodium. The remaining 3 males in the experiment failed to regenerate one or more rays of the anal fin. Ray 1 failed to regenerate in one male, rays 1, 2, 9, and 10 in the second specimen, and rays 1 and 3 in the third. Another atypical development in one male was the fusion of the third ray with the fourth in the regenerating fin. Figure 6C represents the regenerated anal fins of one of these males which shows failure of ray regeneration and fusion of adjacent rays. The only evidence of maleness in this fin is represented by a slight thickening of the basal portion of ray 3. The curve of segment addition during regeneration is graphed in Figure 3E.

III. DISCUSSION

Loss of regenerative capacity of the gonopodia of mature males of *Platypoecilus* and *Gambusia* has been considered to be due to either the presence of an increased amount of androgenic hormone secreted by the fully developed testis or to the previous differentiation of a highly complex gonopodial structure. In *Lebistes,* normal mature males regenerate completely typical gonopodia, and there is no evidence of any loss of regenerative capacity in the adult male. In the experiments reported in this paper untreated castrated males and castrated and normal males treated with Progynon are the only groups in which any of the rays of the anal fins of adult males failed to regenerate. Even in normal males treated during the regeneration process with an excess of androgenic hormone, in the form of an exogenous supply of ethynyl testosterone, no loss of renegerative capacity results. Although the gonopodia formed are not completely typical, being slightly shorter and developing certain abnormal differentiation areas, these results merely indicate the growth-terminating effect of an excessive amount of hormone.

The loss of regenerative capacity in castrated males, in which 50 per cent of the completely castrated fish failed to regenerate one or more rays of the excised gonopodium, was evidenced not only in the rays of the 3–4–5-ray complex but also in the more peripheral rays of the fin. Even in those males in which all rays regenerated, segmentation was often delayed for 20 days. Failure of regeneration of certain fin rays is also seen in castrated males treated with Progynon. Of 8 castrated males in this group approximately 40 per cent failed to regrow one or more rays of the anal fin. Thus treatment with estrogen will not restore regenerative capacity to castrated males, although treatment with ethynyl testosterone will do so. In fact, treatment with Progynon itself results in a slight loss of regenerative capacity in the excised fins of normal males. All 4 normal males treated with Progynon failed to regrow one or more rays of the fin.

These results demonstrate that a high concentration of androgenic hormone does not inhibit gonopod regeneration in males of *Lebistes*. Rather, a certain concentration of this hormone actually stimulates it. Fifty per cent of the males deprived of any hormone by castration operations show a failure of regeneration. Evidently the mechanism by which Progynon brings about a loss of regenerative capacity in normal males is through some inhibition of the testicular hormone. Since Progynon-treated males may form fins closely resembling those of females, it is apparent that either the action of the testicular hormone is inhibited at the target tissue or the amount of testicular hormone secreted is diminished by a direct action of the estrogen on the testis.

Since castrated females will regenerate all rays of the anal fin (Hopper, 1949) and since castrated males often show some indication of loss of regenerative capacity, it is apparent that the differentiation of a complex gonopodium must in some manner affect the capacity for future regeneration. This effect is not marked, however, in *Lebistes*, and in no instance does the loss of regenerative capacity anywhere near approach that observed in *Platypoecilus* and *Gambusia.*

IV. SUMMARY

1. Excised anal fins of mature males regenerate completely and typically.

2. Fifty per cent of the excised fins of castrated males fail to regrow one or more rays of the fin. All fins regenerated by castrated males are female-like in appearance.

3. Progynon has no effect on the regenerative capacity of castrated males, but ethynyl testosterone will increase this capacity.

4. Mature males treated with ethynyl testosterone during anal-fin regeneration will regenerate gonopodia in which growth is terminated prematurely and certain differentiation areas are abnormal. All rays regenerate, however, and in this respect no loss of regenerative capacity results from treatment with an excessive amount of androgenic hormone.

5. Mature males treated with Progynon after anal-fin excision will show a slight loss of regenerative capacity owing to the inhibition of the normal stimulation of the testicular hormone on the regenerating gonopodium.

6. In *Lebistes* it is apparent that any loss of regenerative capacity is not the result of an increased amount of androgenic hormone secreted by the mature testis, but the formation of a complex gonopodial structure probably has some effect on the capacity for future regeneration.

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THE DIPTEROUS FAUNA OF TREE TRUNKS

GEORGE C. STEYSKAL

A VERY interesting but neglected ecological situation is found on and under the bark of the trunks of trees, either live or dead. The greater part of the insect fauna of such situations is composed of Diptera, many of the species of which are to be met with nowhere else. Data concerning the Diptera associated with two species of trees (poplar or cottonwood, *Populus deltoides* Marsh. of most manuals; and common or black locust, *Robinia Pseudo-Acacia* L.) have been gathered by the writer with the assistance of Curtis W. Sabrosky. The results are here presented as an addition to the small fund of knowledge available relating to the insects of such associations, and it is hoped that, in view of the fact that most of the records of insects in such habitats relate to beetles, the data will be of especial interest.

Descriptions of the localities and lists of species will be given, followed by notes on the flies and a tabular summary.

A. THE DIPTERA OF POPLAR TRUNKS (POPULUS DELTOIDES MARSH.)

LOCALITY G. A large tree which put forth its last few leaves in the spring of 1948 was observed on Grosse Ile, an island in the mouth of the Detroit River, Wayne County, Michigan, during the fall of 1947 and the whole season of 1948. The following species were taken from the trunk at various heights from the base up to twelve feet:

Atomosia puella, July 25, 1948 (2).
Berkshiria albistylum, June 22, 27, July 1, 3, 4, 5, 1948 (8).
Chymomyza amoena, June 30, 1948 (1).
Chyromya flava, June 27, 30, July 1, 1948 (3).
Delphinia picta, several specimens at most times during the season.
Dendrophaonia querceti, June 22, 27, July 1, 4, 1948 (6 females).
Desmometopa tarsalis, July 3, 4, 25, 1948 (5).
Drapetis? sp. nov., several specimens.
Eustalomyia vittipes, Sept. 19, 26, 1948 (several).
Gnophomyia tristissima, very abundant (see below).
Lonchaea corticis, very abundant; series taken June 10, 22, 27, July 16, 24, 1948.
L. ruficornis, abundant; June 13, 22, 27, July 3, 11, 16, 24, 1948 (females only).

Medeterus veles, June 22 to July 11, 1948 (several).
Milichiella populi sp. nov. (described on p. 130), June 27, July 3, 5, 25, 1948(9).
Mycetobia divergens, near base of tree, June 27, July 5, 1948 (2).
Neopachygaster maculicornis, June 22, 27, July 1, 4, 11, 25, 1948 (21).
Neurigona perplexa, June 30 (male), July 11 (female), 1948 (2).
Pachygaster pulcher, July 3, 1948 (1).
Pseudotephritis cribellum, Aug. 3, Sept. 7, 1947 (numerous females); June 10, 22, 27, July 5, 16, 1948 (very abundant, mostly females).
P. vau, July 3, 1948 (1).
Pterocalla strigula, May 29, 31, 1948 (3).
Sobarocephala populi sp. nov. (described on p. 129), June 30, 1948(1).
Solva pallipes, June 22, July 1, 5, 24, 1948 (fairly abundant).
Stegana coleoptrata, June 10, 1948 (1).
Thaumatomyia glabra, July 4, 11, 1948 (3).

The black crane fly, *Gnophomyia tristissima,* was by far the most abundant, followed in order of frequency by *Pseudotephritis cribellum, Lonchaea corticis,* and *L. ruficornis.*

As an indication of the specificity of the habitat it is interesting to note that, although the writer has been engaged for more than ten years in compiling a list of the Diptera of Michigan, which at this writing totals more than three thousand species, the following species from the list given above were taken in Michigan for the first time: *Berkshiria albistylum, Drapetis?* sp. nov., *Lonchaea corticis, L. ruficornis, Milichiella populi, Mycetobia divergens, Sobarocephala populi.* Several others are known in Michigan from but very few records. The writer's experience leads him to believe that few or none of the species are strictly accidental in the situation and that they have a biological connection with it.

B. THE DIPTERA OF LOCUST TRUNKS (ROBINIA PSEUDO-ACACIA L.)

The largest number of the Diptera listed under this heading were observed on live trees feeding at the usually fermenting frass protruding from holes, most of which were bored by the cerambycid beetle *Megacyllene robiniae.* The writer is indebted to Curtis W. Sabrosky for the records from localities C, M, and T. Both Sabrosky and the writer worked at localities B and N.

LOCALITY B. Northwestern corner of Branch County, Michigan, May 31, 1942. Row of medium-sized trees along the road, with some pupal skins of the lepidopteron *Prionoxystus robiniae* (det. Carl Heinrich) protruding from the bark.

Callopistromyia annulipes, 1.
Lonchaea nudifemorata, several.
Rivellia viridulans, 2.
Traginops irrorata, 3.

Locality C. Cass County, Michigan, near Niles, June 24, 1943. Roadside grove with much evidence of borer work.

Callopistromyia annulipes, very abundant, feeding at fresh borer frass.
Delphinia picta, 1.
Euxesta notata, 2.
Oscinella catalpae, 1, feeding at frass.
Rivellia viridulans, numerous.
Traginops irrorata, numerous.

Locality D. Detroit, Michigan, grove of small trees with much borer work. The beetle *Megacyllene robiniae* was found on trunk and branches in the fall.

Aulacigaster leucopeza, June 28, 1942, a few, feeding at frass.
Callopistromyia annulipes, June 21, 1942, 4, feeding at frass; July 26, 1942, numerous females ovipositing on dead tree.
Chymomyza amoena, 1, feeding at frass.
Delphinia picta, June 28, 1942, a few, feeding at frass.
Drosophila algonquin, June 21, 1942, numerous; June 28, 1942, a few, feeding at frass.
D. melanica, 2 on June 21 and a few on June 28, 1942, feeding at frass.
Lonchaea polita, June 21, 1942, 3, feeding at frass.
Neurigona lateralis, June 21, 1942, 2 on bark.
Rivellia viridulans, June 21 and 28, 1942, numerous, feeding at frass.
Solva pallipes, June 21, 1942, a few feeding at frass.
Traginops irrorata, June 21 and 28, 1942, a few feeding at frass.

Locality M. Manistee County, Michigan, three miles south of Bear Lake, June 15, 1943. Small trees without much frass.

Aedes vexans, 3 males and 1 female, feeding at frass.
Callopistromyia annulipes, running on bark.
Desmometopa tarsalis, feeding at frass.
Euxesta nitidiventris, feeding at frass.
Hippelates bishoppi, numerous, feeding at frass.
Neurigona sp., running on bark.
Oscinella catalpae, feeding at frass.
Rivellia viridulans, running on bark.
Sphecomyiella valida, running on bark.
Several nitidulid beetles were observed feeding at frass, and *Anisopus* sp., *Scopeuma sp.,* muscid, and sarcophagid flies were also seen on the bark.

Locality N. Nottawa, Michigan, grove of fairly large trees on the shore of Nottawa Lake. Considerable amount of borer work.

Callopistromyia annulipes, July 7, 1943.
Delphinia picta, May 31, 1942, feeding at frass.
Drosophila melanica, June 24, 1943, feeding at frass.
Euxesta notata, May 31, 1942, feeding at frass.
Idana marginata, May 31, June 14, 1942; June 24, July 7, 1943, feeding at frass.
Lonchaea nudifemorata, May 31, 1942, feeding at frass.

Locality T. Traverse City, Michigan, June 17, 1943. Frass just starting to protrude.

Callopistromyia annulipes, fairly numerous, feeding at frass.
Chymomyza amoena.
Delphinia picta, numerous, feeding at frass.
Euxesta notata.
Lonchaea nudifemorata.
Muscina sp.
Neurigona sp.
Rivellia viridulans.
Seioptera vibrans.
Numerous nitidulid beetles also.

C. Remarks upon the Diptera

Suborder NEMATOCERA

Family Anisopodidae

Anisopus sp. — The members of this genus are frequently found on tree trunks. The larvae occur in various substances, particularly dung, but apparently have not been reared from tree trunks.

Mycetobia divergens Wlk. — Malloch (1915: 321) describes the immature stages and their habitats in mulberry and elm trees, where they feed upon exudate from bark injury in the presence of fungus.

Family Tipulidae

Gnophomyia tristissima O. S. — Very numerous on the poplar. Adults were flying over, resting on, and mating on the bark from late May until September 19. By the middle of July hundreds of pupal skins were protruding from cracks in the bark, and flies were observed emerging as late as August 28. Alexander (1920: 935) summarizes the life history of this fly, which he found under the bark of the tulip tree (*Liriodendron Tulipifera* L.), *Populus,* and box elder (*Acer Negundo* L.). Rogers cites the habits of other species of *Gnophomyia* and records immature stages of *G. tristissima* in *Robinia Pseudo-Acacia* and hornbeam (*Carpinus caroliniana;* Rogers, 1927), compares *G. tristissima* with *G. luctuosa* (Rogers, 1928), and reports immature stages in *Salix sp.* and *Populus sp.* (Rogers, 1942: 104).

Suborder BRACHYCERA

Division Orthorrhapha

Family Asilidae

Atomosia puella Wied. — The adult is common resting head downward in many situations. Bromley (1946: 2) states that the group to which *Atomosia* belongs develops in dead wood, but that the larva of *Atomosia* is not known.

Family Dolichopodidae

Medeterus veles Lw. — Frequently found on trunks of various trees. Species of the genus have been reared as predators upon bark beetles (Scolytidae).

Neurigona lateralis Say, *N. perplexa* Van Duzee, etc. — Representatives of the genus *Neurigona* are often found on trunks of various trees. Nothing seems to be known of their immature stages.

Family Empididae

Drapetis? sp. nov. — Minute predaceous flies, the biology of one species of which is treated by Malloch (1917: 402). The larvae occur under bark and in decaying wood.

Family Erinnidae (Xylophagidae)

Solva pallipes Lw. — An abundant species that has been observed on many species of trees. Townsend (1893b: 163), Malloch (1917: 342), Greene (1926: 4), and Johannsen (1922: 145) have described the biology of the species and have cited it as developing under the bark and in wounds of *Populus sp.*, *Liriodendron Tulipifera*, and *Robinia "podagrica."* Malloch found the larvae predaceous, but Greene states that they are "usually scavengers and may occasionally be predaceous."

Family Stratiomyidae

Berkshiria albistylum Johnson (*Johnsonomyia aldrichi* Malloch). — There seem to be no data on the immature stages of this species.

Neopachygaster maculicornis Hine. — Malloch (1917: 326) reared this species from larvae collected in bark of fallen elm trees, and Pechuman (1937) also found it in elm. Greene (1917: 146) described the immature stages from under bark of *Liriodendron*. Johannsen (1922) has also described the immature stages.

Pachygaster pulcher Lw. — No data seem to be available concerning the immature stages.

Division CYCLORRHAPHA

Family Agromyzidae

Traginops irrorata Coq. — Johnson (1925: 289) found the adult at fermenting sap of red oak, in which situation the present writer has also taken it. The immature stages seem to be unknown.

Family Aulacigasteridae

Aulacigaster leucopeza Mg. — Malloch and McAtee (1924: 39) have described the immature stages from sap in wounds on trunks of unidentified trees. Séguy (1934a: 396) describes the immatures from "pourriture liquide des ulcères des ormes." The writer has also taken adults at wounds on elm, and also at sapsucker holes on sugar maple. The genus is usually classified with the Drosophilidae.

Family Chloropidae

Hippelates bishoppi Sabrosky. — A number of species of *Hippelates* are of economic importance, but little seems to be known of their biology. The present species has been described quite recently.

Oscinella catalpae Malloch. — According to information kindly furnished by Curtis W. Sabrosky, material in the United States National Museum was reared as a parasite of a lepidopterous gall formed on black locust, *Ecdytolopha insiticiana* Zeller, and is known from larvae reared in seed and pods of *Catalpa* and in "gall on cherry."

Thaumatomyia (= *Chloropisca*) *glabra* Mg. — Parker (1918) has described the life history. This very common species is apparently predaceous, although Séguy (1934b: 196) says that it seems to be "polyphage."

Family Chyromyidae

Chyromya flava L. — The immature stages are apparently unknown. The adults are sometimes found at windows in houses.

Family Clusiodidae

Sobarocephala populi sp. nov. (see below). — This species likely has a biology similar to that of *S. flaviseta* Jns. (*S. convergens* Malloch) as described by Malloch (1918).

Family Drosophilidae

Chymomyza amoena Lw. — Frequently found on freshly cut wood, garbage, etc., and has been reared from walnut and butternut hulls and rotten corn. The immature stages have been described by Patterson (1943: 38).

Drosophila algonquin Sturt. and Dobzh. — In the "affinis group," to which this species belongs, the immature stages of only *D. affinis* have been described (Patterson, 1943: 74); they were from material reared on banana. Adults of *D. affinis* have been taken at sap and fungi. The writer has taken *D. algonquin* adults in April at sugar maple sap running from sapsucker holes.

D. melanica Sturt. — The writer's material is probably referable to the subspecies *paramelanica* Patterson, which, together with its immature stages, was described in 1943 (Patterson, p. 166). *D. melanica* has been reared from butternut hulls and the adults have been taken at *Liriodendron* sap.

Stegana coleoptrata Scop. — Séguy (1934b: 184) states that the larva lives in wood, notably that of poplar.

Family Lonchaeidae

Lonchaea corticis Taylor. — This form was described (Taylor, 1928a: 191) from material reared from white pine (*Pinus strobus*) shoots infested with the weevil *Pissodes strobi.* The same author published notes on the association elsewhere in the same year (1928b: 217). The writer's material agrees very well with Taylor's description, but he feels that both it and Taylor's should be compared with the European species *L. palposa* Zett., which has been found in the larval stage under the bark of willow. Our material was abundant on poplar and could be seen at any time probing crevices in the bark with their ovipositors. All specimens taken from the bark were females. Three males were taken on the evening of June 27, 1948, while they were flying around the tree at a height of seven or eight feet.

L. nudifemorata Malloch. — The only place that we have taken this species is at borer frass on *Robinia.* No other habitat records are available.

L. polita Say. — A common species which has been reared from many kinds of material, including old pumpkin vines, cabbage stalks, butternut hulls, and elm logs, and also under bark of *Juglans regia, Pinus strobus,* and *Robinia Pseudo-Acacia.* It is likely that some of these rearings are actually of other species.

L. ruficornis Malloch. — Observed ovipositing in crevices in poplar. Females only were found. No other biological data are available.

Family Milichiidae

Desmometopa tarsalis Lw. — No biological data on this species are available, but the related *D. latipes* Mg. has been reared from coniferous branches infested with the weevil *Pissodes strobi* (Taylor, 1928a: 224); it has been taken as adult in a bird's nest and has been seen darting under a feeding spider. *D. m-nigrum* Zett. has been reared from cow manure. Adults of several species of this and other genera of the family are frequently taken in sunlight on dry dead wood, such as fence posts, rail fences, and telephone poles.

Milichiella populi sp. nov. (described in the next section). — Séguy (1934a: 638) cites larvae of the related European *M. argyrogastra* Perris found "sous l'écorce vermoulue d'une branche de tilleul."

Family Otitidae (Ortalidae)

Callopistromyia annulipes Macq. — Frost (1928: 169, and 1929: 84) found the species abundantly attracted to molasses and syrup bait traps in a peach orchard. It has apparently never been reared.

Delphinia picta R.-D. — Frost (as cited) found only one specimen in each of two years' collecting in Pennsylvania, but in Michigan the species is abundant and may be taken nearly anywhere during the summer. Nothing seems to be known of its immature stages.

Euxesta nitidiventris Lw. — The larva has been reared from under the bark of dead pecan (*Carya pecan;* Brues, 1902; quoted by Hendel, 1910). It has also been reared from yam and sweet corn in subtropical America (Chittenden, 1911).

E. notata Wied. — Hendel (1910) summarized our knowledge of this species up to that date. It has been reared since from decaying onions and from sweet peppers, and Hutchison (1916) has described the larva. It is apparently a saprophyte in a wide variety of media, including human feces.

Idana marginata Say. — Not a common fly; no biological data available.

Pseudotephritis spp. — No biological data are available on *P. cribellum*. *P. vau* was stated by Johnson (1899) to be common in the larval stage under "bark," and Weiss and West (1920) have reared it from the fungi *Lenzites betulina* and *Polyporus hirsutus*. *Pseudotephritis corticalis* was described in all stages by Greene (1917) from material found in frass under bark of chestnut (*Castanea dentata*).

Pterocalla strigula Lw. — Not a common fly. Nothing is known of its biology, except that Alexander (1920: 936) found the larva under bark of *Acer Negundo*.

Rivellia viridulans R.-D. — The writer considers this a common species, especially around leguminous plants, but nothing seems to be known of its immature stages or life history.

Seioptera vibrans L. — A species very common here and in Europe. Hendel (1910) summarized the biology as known to that date. It has been reared several times from earth or from earth mixed with horse manure, and was found once injuring the stems of *Dianthus carthusianorum,* but no description of its immature stages seems available.

Family Pyrgotidae

Sphecomyiella valida Lw. — Flies of this family are known to be parasitic upon beetles. The related *Pyrgota undata* parasitizes species of *Phyllophaga,* but nothing seems to be known about the biology of the present species.

Family Muscidae (including Anthomyiidae)

Dendrophaonia querceti Bouché. — Séguy's great work on the Muscidae (1938) gives a complete bibliography of this species, concerning which little has been published in North America.

Eustalomyia vittipes Zett. — The foregoing paragraph applies to this species also.

Muscina sp. — Flies of this species are very common and apparently are general scavengers and even parasites.

Scopeuma sp. (= *Scatophaga sp.*). — This genius includes predaceous flies, which typically develop in manure.

D. DESCRIPTIONS OF TWO NEW SPECIES OF DIPTERA

Sobarocephala populi sp. nov. Clusiodidarum.

Male. Length, 3.17 mm.

Yellow, except blackish ocellar spot and elongate but diffuse brown spot at end of second wing vein. Bristles black, those of the abdomen a little brownish. Hairs of head, thoracic dorsum, and abdomen blackish, those of pleura, sternum, and legs yellow.

Head with front 0.4 total width of head, a little narrowed anteriorly. Third antennal joint circular in profile, arista loosely short-plumose. Ocellar and postocellar bristles fine, each about as long as half the frontal width.

Thorax with small but distinct prescutellars and about six rows of hairs between the anterior dorsocentral bristles. Scutellum with a long pair of cruciate apicals and two small laterals on each side. Wings hyaline except the spot at end of second vein, the veins otherwise yellow. Last two sections of fourth vein as 1 : 4.3. Squamae with blackish border and ciliae.

Fore femora with complete row of posteroventral bristles; middle femora with a complete posteroventral row of 16–20 bristles, each about half as long as femoral diameter, and in the distal half a row of about eight somewhat smaller anteroventral bristles; posterior femora with a few anteroventral setose hairs distally. Middle tibiae with ventral hairs in distal half noticeably erect. Fore tarsi slender, nearly 1.5 times as long as their tibiae. Middle and hind tarsi approximately 1.2 times as long as their tibiae.

Abdomen with marginal setae of second to fifth tergites about as long as the tergites. Hypopygium about as long as depth of abdomen, the lamellae in profile about two thirds as long as the hypopygium, oval, about 1.5 times longer than wide.

Holotype, male, Grosse Ile, Michigan, on bark of trunk of dead *Populus deltoides*, June 30, 1948; in University of Michigan Museum of Zoology.

The species runs in the key of Melander and Argo (1924: 34) to *Sobarocephala flava* M. and A., described from females only, but the setose femora, yellow anterior tarsi, and exceptionally long ultimate section of fourth vein make its identification with that species inadvisable. It may be remarked that, although the description of *S. flava* states that the last two sections of the fourth vein are as 1 : 3, the photograph shows a proportion of at least 1 : 3.6.

Milichiella populi sp. nov. Milichiidarum.

Male. Length, 2.5 mm.

General color black, middle and hind basitarsi brownish, especially toward base. Palpi and antennae entirely black. Haltere knob yellow to brown, stem blackish. Squamae and their ciliae whitish. Wings white, the veins scarcely yellowish.

Head with front dull leaden-bluish pruinose, with two to three pairs of short interfrontal setae. Ocellar triangle small, equilateral. Cheeks linear.

Thoracic dorsum pale gray pruinose, sometimes with a pair of incipient broadish acrostichal brown stripes anteriorly. Hairs of thorax bristly. One distinct dorsocentral bristle, but the bristle anterior to it is more than half its length. Four to six rows of acrostichal setae and a distinct pair of prescutellars. Scutellum paraboloid in outline, proportion of length to width between basal bristles as 9 : 15. Pleura dull blackish with some subshining areas; mesopleura bare; sternopleura with one long bristle and one to several bristly hairs. Wings with anterior crossvein approximately its length apicad of the costal break; the ultimate section of fourth vein 3.3 times as long as the penultimate; third and fourth veins only slightly convergent apically.

Abdomen bright silvery pruinose, except first tergite, anterior corners of second tergite, posterior edge and corners of fifth tergite, and venter. Second tergite with basal triangular emargination one fourth the length of the tergite, which is twice as long as the third; it in turn is equal in length to the fourth. Second, third, and fourth tergites dorsally bare, except a subapical row of nine to thirteen short setulae. Lateral setae, even basally and apically, not strikingly long.

HOLOTYPE, male, Grosse Ile, Michigan, on bark of trunk of dead *Populus deltoides*, July 5, 1948; in University of Michigan Museum of Zoology; paratypes, same locality, June 27, July 3, 25, 1948, in University of Michigan Museum of Zoology, United States National Museum, and the author's collection.

This form has several of the characters of *Eccoptomma* Becker, a group which Becker himself said "darf als Unter Gattung angesehen werden." *Milichiella cinerea* Coquillett is apparently the nearest relative of *M. populi*. According to information kindly furnished by Curtis W. Sabrosky, the type of *M. cinerea* now consists of only a piece of thorax and a leg buried in glue; a Santo Domingo specimen (recorded by Malloch, 1913: 132) differs from *M. populi* as follows: palpi yellow; third antennal segment conspicuously yellow at base below; rather narrow brown stripes on notum (not too clear, not in best of condition); front bright gray pollinose, brighter than the thorax; scutellar length to width between basal bristles as 12 to 18.

E. SUMMARY

The occurrences of Diptera, both on poplar (Locality G) and on black locust (the remaining localities), are summarized in Table I, in which the species are arranged taxonomically.

TABLE I

LIST OF DIPTERA, WITH TABULATION OF OCCURRENCES

SPECIES	Locality						
	G	B	C	D	M	N	T
Anisopodidae:							
Anisopus sp.	..	..	..	..	+	..	..
Mycetobia divergens Wlk.	+	..	..	..	..	..	..
Culicidae:							
Aedes vexans Mg.	..	..	..	..	+	..	..
Tipulidae:							
Gnophomyia tristissima O. S.	+	..	..	..	..	..	..
Asilidae:							
Atomosia puella Wied.	+	..	..	..	..	..	..
Dolichopodidae:							
Medeterus veles Lw.	+	..	..	..	..	..	..
Neurigona lateralis Say	..	..	..	+	..	..	..
N. perplexa Van Duzee	+	..	..	..	..	..	..
N. sp.	..	..	..	..	+	..	+
Empididae:							
Drapetis ? sp. nov.	+	..	..	..	..	..	..
Erinnidae:							
Solva pallipes Lw.	+	..	..	+	..	..	..
Stratiomyidae:							
Berkshiria albistylum Jns.	+	..	..	..	..	..	..
Neopachygaster maculicornis Hine	+	..	..	..	..	..	..
Pachygaster pulcher Lw.	+	..	..	..	..	..	..
Agromyzidae:							
Traginops irrorata Coq.	..	+	+	+	..	..	..
Aulacigasteridae:							
Aulacigaster leucopeza Mg.	..	..	..	+	..	..	..
Chloropidae:							
Hippelates bishoppi Sabr.	..	..	..	..	+	..	..
Oscinella catalpae Mall.	..	..	+	..	+	..	..
Thaumatomyia glabra Mg.	+	..	..	..	..	..	..
Chyromyidae:							
Chyromya flava L.	+	..	..	..	..	..	..
Clusiodidae:							
Sobarocephala populi sp. nov.	+	..	..	..	..	..	..
Drosophilidae:							
Chymomyza amoena Lw.	+	..	..	+	..	..	+
Drosophila algonquin Sturt. and Dobzh.	..	..	..	+	..	..	..
D. melanica Sturt.	..	..	..	+	..	+	..
Stegana coleoptrata Scop.	+	..	..	..	..	..	..
Lonchaeidae:							
Lonchaea corticis Taylor	+	..	..	..	..	..	..
L. nudifemorata Mall.	..	+	..	..	..	+	+
L. polita Say	..	..	..	+	..	..	..
L. ruficornis Mall.	+	..	..	..	..	..	..
Milichiidae:							
Desmometopa tarsalis Lw.	+	..	..	..	+	..	..
Milichiella populi sp. nov.	+	..	..	..	..	..	..

TABLE I (*Concluded*)

Species	Locality						
	G	B	C	D	M	N	T
Otitidae:							
Callopistromyia annulipes Macq.	..	+	+	+	+	+	+
Delphinia picta R.-D.	+	..	+	+	..	+	+
Euxesta nitidiventris Lw.	..	..	..	..	+	..	..
E. notata Wied.	..	..	+	..	..	+	+
Idana marginata Say	..	..	..	..	..	+	..
Pseudotephritis cribellum Lw.	+	..	..	..	..	..	..
P. vau Say	+	..	..	..	..	..	..
Pterocalla strigula Lw.	+	..	..	..	..	..	..
Rivellia viridulans R.-D.	..	+	+	+	+	..	+
Seioptera vibrans L.	..	..	..	..	..	..	+
Pyrgotidae:							
Sphecomyiella valida Lw.	..	..	..	..	+	..	..
Muscidae:							
Dendrophaonia querceti Bouché	+	..	..	..	..	..	..
Eustalomyia vittipes Zett.	+	..	..	..	..	..	..
Muscina sp.	..	..	..	..	..	..	+
Scopeuma sp.	..	..	..	..	+	..	..

Grosse Ile, Michigan

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GEOGRAPHY

THE MAJOR PORTS OF MICHIGAN

ALBERT G. BALLERT

AMONG the states of the nation Michigan ranks first in the number of ports having an annual traffic of at least one million short tons. This is the volume used in giving a port major ranking, and "short ton" denotes the measure of weight throughout this paper. In 1946, the last year for which comparative data are available, twelve ports of Michigan had sufficient tonnage to be termed "major."[1] Since the Great Lakes million-ton ports numbered thirty-six in that year, Michigan accounted for one third of the total. Manuscript records of the United States Corps of Engineers, Detroit District, indicate that fourteen ports in the state held this position in 1947.

The geographic situation of Michigan's two peninsulas with respect to the Great Lakes provides the state with the longest shoreline in the nation — 2,242 miles.[2] All the principal segments of this great shoreline have one or more major ports, but variations in the general character of the traffic through the different ports suggests a division of the group into three types — shipping, receiving, and car ferry. Their geographic distribution shows a pattern of zonation which reflects the economy of several sections of the state (Fig. 1).

The six principal shipping ports of Michigan are also the northernmost of the group. Huge bulk shipments of a single commodity — limestone or iron ore — are the rule for each of these ports. By contrast, the five receiving ports are in the southern portion of Michigan, all within the area known as the American Manufacturing Belt. Their receipts are utilized for power and in the production of commodities of relatively high value while but a small amount of goods of the type commonly transported on the Great Lakes is available for shipment. The remaining three ports lie along the middle section of the Lower Peninsula's west shore. Lake Michigan, a sixty- to eighty-mile-wide barrier to east-west rail routes, has prompted the development of sufficient railroad car-ferry tonnage for all three termini along the east shore of the lake to be included among the ports considered here. The dependence of these break-of-bulk points

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[1] *Annual Report of the Chief of Engineers, 1947,* Part 2 (Washington, 1948).

[2] This is the mainland shoreline of the state. Michigan islands add 879 miles more, according to the Michigan Geological Survey. By comparison, Florida's coastline is 2,077 miles (U. S. Bureau of the Census, *Areas of the United States: 1940* [Washington, 1942]). Since Michigan's land and river boundaries total only 431 miles, 84 per cent of the land mass of the two peninsulas is bounded by the Great Lakes.

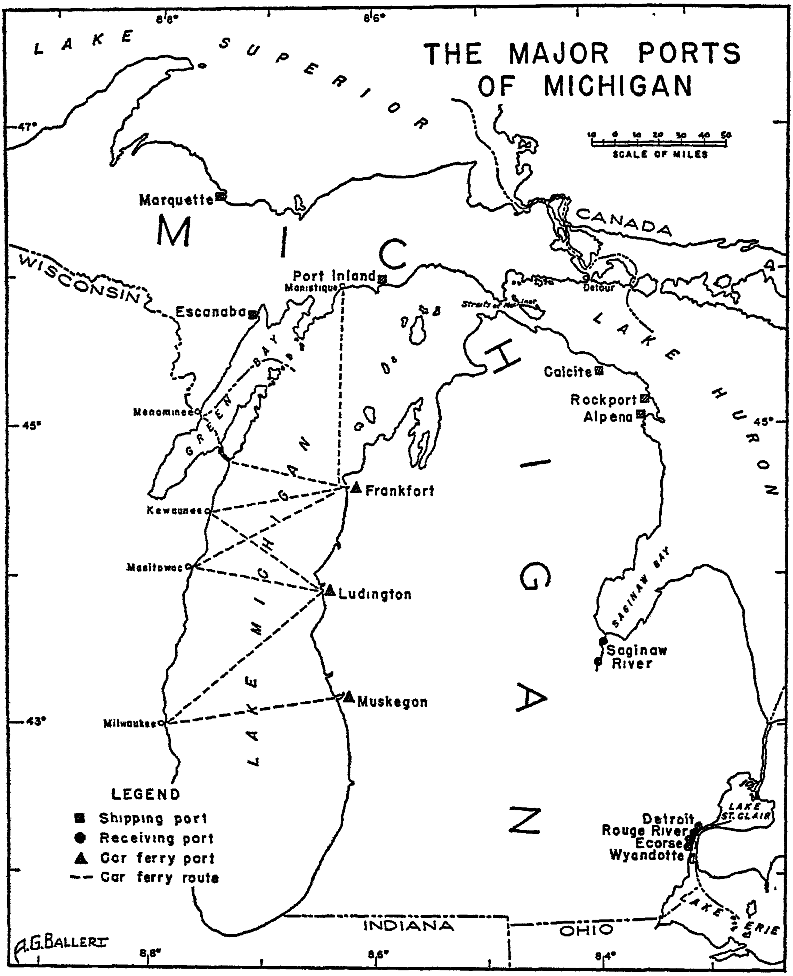

FIGURE 1

upon car-ferry tonnage varies in relation to the extent to which other activities are developed, particularly industries utilizing lake transportation.

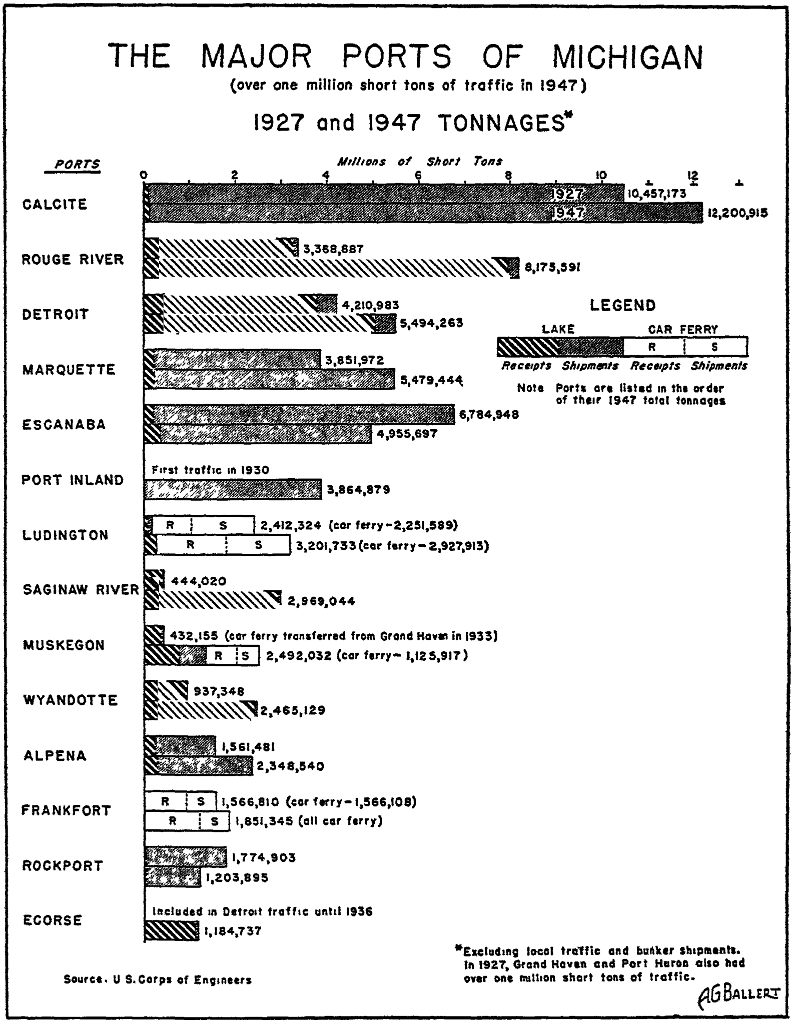

FIGURE 2

The major ports have shown, in general, an increasing tonnage over a period of two decades, 1927 to 1947 (Fig. 2). Since the two years mentioned are in similar periods of commercial activity, it is appropriate to compare them. Of the fourteen ports only Escanaba and Rockport, both bulk shipping points, had a lower tonnage in 1947. If 1927 port data are compared with those for 1940, a somewhat less prosperous time, the only additional ports with a decline in the latter year are the car-ferry termini of Ludington and Frankfort. All the major receiving ports have had a substantial increase in their traffic over the twenty-year period.

Between 1927 and 1947 five additional ports attained a million-ton status. Three of the group, Saginaw, Wyandotte, and Ecorse, are receiving ports. Their rise was associated with gradual industrial expansion in their respective water-front areas. Abruptness marked the growth of the other ports; the shipping port of Port Inland was privately developed in 1930, and Muskegon's port rank was enhanced by the transfer of car-ferry service from Grand Haven. At the latter port, however, receipts and shipments by lake carrier alone have attained an annual volume well over a million tons.

Among the commodities moving through the ports only bituminous coal appears in all the traffic (Fig. 3).[8] At the six shipping ports it represents from 85 to 100 per cent of the receipts. It is even more significant in the traffic of the major receiving ports, which have greater variety and greater total volume of inbound tonnage. At four out of five such ports coal accounts for 33 to 85 per cent of the receipts. It also plays an important rôle in the traffic of the three car-ferry ports.

SHIPPING PORTS

All the major shipping ports of Michigan have had their origins in carrying out the functions for which they are now dominant. Three, Alpena, Escanaba, and Marquette, have developed additional activities and an urban landscape. The other three, Calcite, Port Inland, and Rockport, are private ports which lack community development. Included in this group are some of the oldest as well as the most recently developed major ports of the Great Lakes. The transfer points for iron ore arose long before limestone became an important item in the traffic of the lakes.

Marquette, the initial ore-shipping port in the Great Lakes region, was founded as Worcester at the mouth of the Carp River in 1849 (Fig. 4). This town, renamed after the Jesuit missionary the following year,

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[8] For an account of this traffic see A. G. Ballert, "The Coal Trade of the Great Lakes and the Port of Toledo," *Geog. Rev.*, 38 (1948): 194–205.

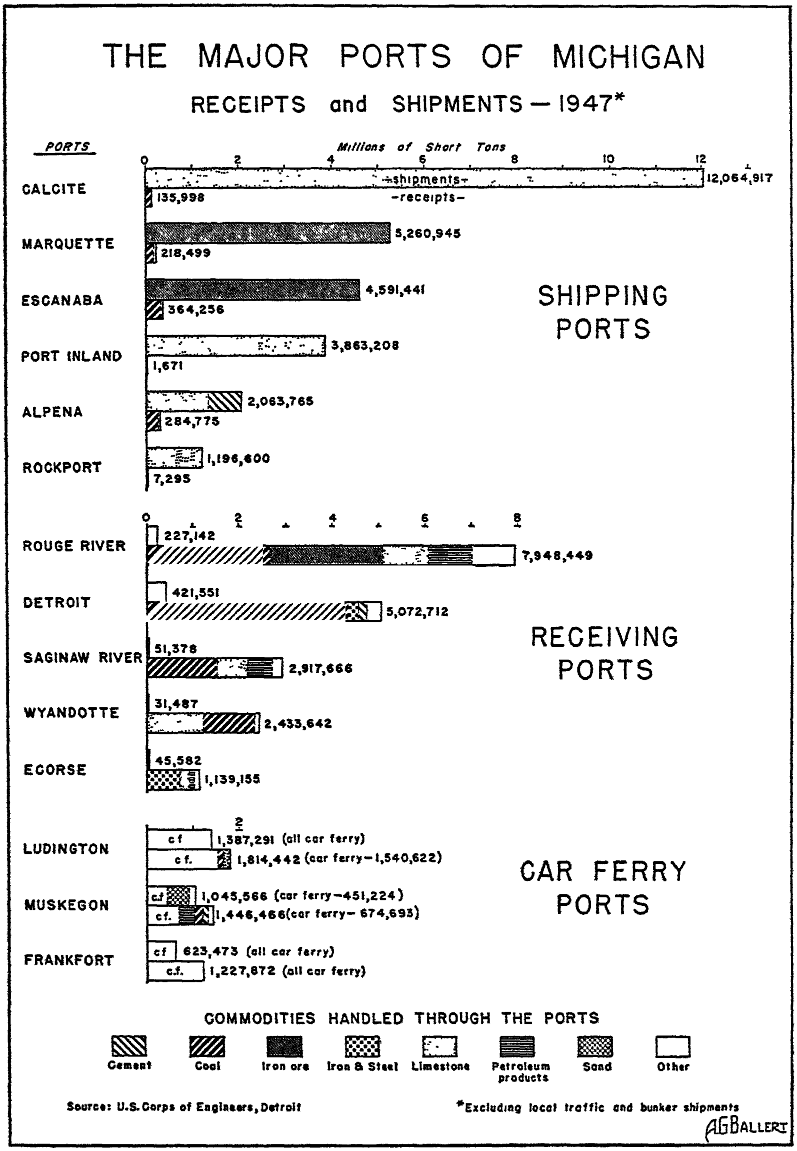
THE MAJOR PORTS OF MICHIGAN
RECEIPTS and SHIPMENTS — 1947*
PORTS
Millions of Short Tons
0 2 4 6 8 10 12
CALCITE
-shipments-
12,064,917
135,998
-receipts-
MARQUETTE
5,260,945
218,499
ESCANABA
4,591,441
364,256
PORT INLAND
3,863,208
1,671
ALPENA
2,063,765
284,775
ROCKPORT
1,196,600
7,295
SHIPPING PORTS
0 2 4 6 8
ROUGE RIVER
227,142
7,948,449
DETROIT
421,551
5,072,712
SAGINAW RIVER
51,378
2,917,666
WYANDOTTE
31,487
2,433,642
ECORSE
45,582
1,139,155
RECEIVING PORTS
2
LUDINGTON
cf
1,387,291 (all car ferry)
c f.
1,814,442 (car ferry—1,540,622)
MUSKEGON
cf
1,045,566 (car ferry—451,224)
cf.
1,446,466 (car ferry— 674,693)
FRANKFORT
cf
623,473 (all car ferry)
c.f.
1,227,872 (all car ferry)
CAR FERRY PORTS
COMMODITIES HANDLED THROUGH THE PORTS
Cement
Coal
Iron ore
Iron & Steel
Limestone
Petroleum products
Sand
Other
Source: U.S. Corps of Engineers, Detroit
*Excluding local traffic and bunker shipments
AGBALLERT

FIGURE 3

was established as a transshipping point for ore from the first Lake Superior iron mine (Jackson), opened a few miles inland in 1846. Regular shipments did not begin, however, until 1856, when uninterrupted lake transportation became available after the opening of the ship canal at Sault Ste. Marie in 1855.[4] By 1857 a railroad between the mines and the lake had been completed. Loading docks were built on Iron Bay, now Marquette Bay, at the terminus of this line, and the focal point of the city became fixed in an area adjacent to these facilities (Pl. I). It appears that the annual tonnage first passed the million mark in 1884.[5] Another railroad, completed in 1896 by an iron-mining company (Cleveland Cliffs), terminated about three miles to the north. The city has expanded to encompass these docks, but no rival commercial center has developed here. In 1947, 89 per cent of the iron ore transshipped at Marquette was handled at this harbor.[6] Annual shipments of the five American iron-ore ports normally show Marquette with the smallest volume, although it has the lowest mine-to-dock rail freight rates.

Escanaba, the only ore-shipping point below the Sault Canal, was the second Great Lakes port to handle this commodity, and it is second only to Buffalo (which ships coal) for honors as the earliest million-ton port on the "Inland Seas." As the development of this port was a private venture, early tonnage data are not available in the *Annual Report of the Chief of Engineers*. From 1887 to the present, except for 1932, the annual shipments have been above the million mark.[7] It appears that Escanaba rightfully laid claim in the 1880's to the title of "Iron Port of the World." At that time it was not uncommon for sixty to seventy vessels (of 3,500–4,000 tons capacity) to be awaiting their turn at the loading docks, but the Minnesota ranges soon were to diminish greatly the prominence of Escanaba and Marquette as ore ports.

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[4] *History of the Upper Peninsula of Michigan* (Chicago: Western Historical Co., 1883), p. 413.

[5] The earliest recorded date for port shipment of iron ore as given in *Lake Superior Iron Ores* (published by the Lake Superior Iron Ore Association, Cleveland, 1938), p. 310, is 1884. According to this source, a shipment of 1,028,000 tons was made from Marquette in that year. This date is substantiated by a statement made elsewhere to the effect that the traffic in iron ore passing through the Sault locks first exceeded a million tons in that year (United States Corps of Engineers, *Lake Commerce Passing through Canals at Sault Ste. Marie, Michigan and Ontario: 1947* [Washington, 1948], p. 9. Until 1885 Marquette was the only Lake Superior ore port.

[6] In the *Annual Report of the Chief of Engineers* these facilities are designated as being at Presque Isle Harbor.

[7] A letter from the Lake Superior Iron Ore Association, February 8, 1949, states that Escanaba first shipped over one million short tons (1,171,000 gross tons) in 1882.

The location of Escanaba on Little Bay de Noc, a northern arm of Green Bay, suggests for it such physical advantages over other ore ports as greater proximity to the major markets and a longer navigation season (Fig. 4). It does have both these advantages, but the significance of dis-

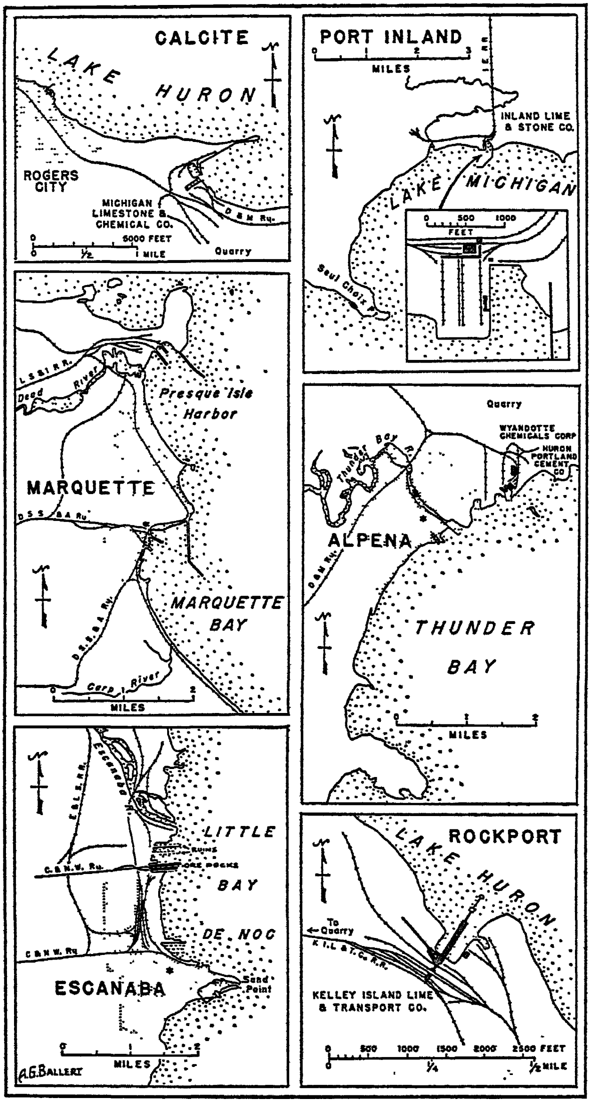

FIG. 4. Major shipping ports of Michigan

tance is minimized by such economic factors as contractual arrangements, mine ownership, and the grade of ore required. Also, the navigation season is somewhat shortened because the port's situation in a narrow and sheltered bay brings about an extended period of ice.[8]

Growth of the community, known originally as Sand Point, closely parallels the port development. Until a branch line of the Chicago and North Western Railway was completed to Negaunee in the Marquette Range in 1864, settlement at Escanaba was very minor. The first ore docks were placed in operation the following year.[9] A number of additional docks were built and rebuilt at later dates, and in 1890 a rail connection to Iron Mountain gave the port access to the Menominee Range.

During World War II additional ore docks were built at Escanaba to insure movement of the huge Lake Superior ore production should the Sault locks be damaged. These facilities have since been removed.

The four limestone ports of Michigan contributed nearly 18.5 million tons, or 88 per cent, to the total volume of stone shipped on the Great Lakes in 1947.[10] This tonnage also represents about 82 per cent of the total amount quarried in Michigan during the same year.[11] Since about 1915, when limestone first became a significant commodity in lake traffic, with less than 4 million tons, the volume has increased until at present it is surpassed only by ore and coal. The outcropping of high-quality limestone beds along the lake shore of Michigan's southeastern Upper Peninsula and northeastern Lower Peninsula has prompted this growth. Practically all the output of the four ports (99 per cent in 1947) is marketed by low-cost lake carriers because of close proximity of the quarries to the ports they supply and because nearly all the demand for limestone comes from points hundreds of miles away in the Manufacturing Belt.

Several uses are made of the limestone carried on the lakes, but by far the most important one is for flux. In 1947 more than one half of the tonnage shipped from the four limestone ports was for this purpose, with blast-furnace flux representing about 41 per cent and open hearth over 12 per cent.[12] The rest of the total shipments are principally for use in the chemical industry (about 22 per cent) and in cement manufacture (about 13 per cent). Concrete aggregates and agricultural lime serve other needs.

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[8] Comparative lake-vessel freight rates per gross ton in 1947 were: Escanaba to Lake Michigan ports, 75½ cents, and to Lake Erie ports, 90½ cents; head of Lake Superior to lower lakes ports, 1.15½ cents. The average navigation season for Escanaba is from April 15 to December 10, and for Duluth, from April 23 to December 10 (United States Corps of Engineers, *Survey of Northern and Northwestern Lakes*, Bulletin No. 57 [April, 1948]).

[9] Van Cleve, F. H., "Railroads of Delta County," *Michigan History Magazine*, 6(1922):462.

[10] A record was set by the 20.9 million tons shipped that year, but it was surpassed in 1948 by a volume of 22.3 million tons (*Annual Report of the Lake Carriers' Association: 1948* [Cleveland, 1949], p. 114).

[11] The Michigan Geological Survey estimates the amount of limestone quarried in 1947 for all purposes as approximately 22.4 million tons.

The port of Calcite, near Rogers City, is to the Great Lakes limestone trade what Duluth-Superior and Toledo are to the ore and coal traffic respectively. It appears that this port, which lays claim to having the world's largest limestone quarry (more than ten miles of working face), is also the greatest shipper of stone. The 12 million tons shipped in 1947 comprised approximately 58 per cent of the Great Lakes total.[13] Despite these superlatives the harbor, which handled over 1,000 vessels in 1947, is small (Fig. 4). Lake carriers must be towed in stern first for loading.

The Michigan Limestone and Chemical Company, a subsidiary of the United States Steel Corporation, opened the port of Calcite in 1913. Use of more than half of the huge shipment by the iron and steel industry is explained by the ownership of this development. The only receipt at this port in 1947 was 136,000 tons of solid fuel, of which two thirds was used as bunker fuel for the lake carriers.

Second among the Great Lakes ports in volume of stone shipped is Port Inland, located about eighteen miles east of Manistique (Fig. 4). Like Calcite, it is a private development, being the harbor of the Inland Lime and Stone Company, a subsidiary of the Inland Steel Company. As the first cargo was shipped in November, 1930, this is in all probability the most recent large-tonnage port opened on the Great Lakes. Since high-quality limestone is not available along the lake-shore zone — dolomite of about 55 per cent calcium carbonate appears here — an electric railroad has been extended inland about seven and one-half miles to the site of the company's quarry. In 1947 total shipments were slightly over 4 million tons, with 30 per cent being sent to the parent company at Indiana Harbor.[14] Two thirds of the total tonnage in that year was for flux. This indicates the basic reason for utilizing Burnt Bluff limestone, which is approximately 96 per cent calcium carbonate. There is no settlement near the harbor and crushing plant at Port Inland (Pl. II), and hence the workers live in Manistique and intervening places such as Gulliver.

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[12] The percentages are based on data obtained from the Michigan Geological Survey. Had the estimates been founded on the statistics of the United States Corps of Engineers, a common source for such data, the flux would have represented about 37 per cent of the total shipments. This higher percentage is due to the classification by the latter organization of a much greater proportion of the shipments as "not otherwise specified."

[13] In 1948 the volume of stone shipped from Calcite was over 13 million tons.

[14] Letter from Mr. A. J. Cayia, president, Inland Lime and Stone Co., October 12, 1948. About 96 per cent of the total shipments were transported by lake carrier.

Rockport, another private harbor, is the shipping point for limestone from the Presque Isle quarry, which is about seven miles to the north of it (Fig. 4). Stone has been taken from this site since 1933, when a company railroad was built to connect it with the port. From 1915 until 1933 limestone was quarried at Rockport, but since the bedrock in that vicinity contains silica and other minerals objectionable for use in the iron and steel industry, activities were shifted to the Presque Isle quarry, where there occurs the nearly pure formation (Dundee) that is used at Calcite.[15]

The Kelley Island Lime and Transport Company, which derives its name from the widely known Kelley's Island in Lake Erie, where it maintained limestone quarries for many years, began operations at Rockport in 1923. While tonnage is the lowest among the stone-shipping ports considered here, a greater balance exists in the various uses to which the product is put. This is explained by the independent status of the company. All shipments are by lake carrier, but in the earlier years of the development a branch-line railroad extended to the port from Alpena. Some of the workers live as far away as this city, for no organized community exists at Rockport.

In several ways Alpena differs from the other major shipping ports of Michigan. Whereas they are handling the one commodity which provided their original traffic, Alpena shifted from lumber in the 1800's to minerals in the present century.[16] Furthermore, over one third of the outbound tonnage in 1947 was processed before shipment.

Although the port is termed Alpena Harbor, the private docks on Thunder Bay east of the city (Fig. 4) handle all the shipments and a large portion of the receipts, 97 per cent of which is coal. Limestone and cement constitute all the shipments, with the former representing about two thirds of the total.

The quarry and the plant from which these products come were the first in Michigan to make large-scale use of lake transportation.[17] In

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[15] Morrison, P. C., "The Michigan Limestone Industry," *Econ. Geog.*, 18 (1942): 263–266. During the 1949 season the Presque Isle quarry was idle.

[16] The peak year of lumber shipping at Alpena was about 1889.

[17] Morrison, P. C., "Cement Production and Trade on the Great Lakes," *Econ. Geog.*, 20 (1944): 41.

1903 the Michigan Alkali Company (now the Wyandotte Chemicals Company) opened their present quarry near Alpena and shipped stone to their alkali plant at Wyandotte. Small pieces of limestone serve no purpose in this industry, and hence a subsidiary organization, the Huron Portland Cement Company, was established to utilize it.[18] Shale, the other necessary raw material, is quarried a few miles to the west. Total shipments of limestone and cement first reached one million tons in 1914. From 1931 to 1946 the Thunder Bay Quarries Company also contributed limestone to the outbound traffic.

Distribution of the products shipped from well-sheltered Thunder Bay largely follows a set pattern. Company-owned vessels carry practically all the limestone to Wyandotte and distribute the cement to ten lake ports where storage and marketing facilities are maintained.[19]

Two additional locations in the zone of Michigan's limestone ports warrant mention here, although they are not major ports at present. One point is Detour, primarily a bunkering port located at the southern end of the principal freighter route connecting Lake Huron and Lake Superior (Fig. 1). The total traffic at this strategic location was over 1.1 million tons in 1947, excluding the 0.5 million tons of bunker coal shipped. The latter volume makes this the leading bunker port on the Great Lakes. Shipments of limestone, the only significant outbound commodity originating here, amounted to nearly 600,000 tons in 1947. The annual tonnage of this mineral has increased rapidly, but actually it is shipped from Drummond Island, east of Detour Passage.[20] Receipts of the coal mentioned above for reshipping as bunker fuel provided the remaining traffic. Because of the in-transit character of this product and the shipment of limestone from Drummond Island, the grounds for including Detour among the major ports are diminished.

A port which in the future will undoubtedly become a million-ton shipping point is at present being developed about midway between Detour and the Straits of Mackinac. At this location, several miles east of Cedarville, the operators of the huge Calcite quarry will have facilities for shipping dolomite quarried in the vicinity. The large expenditure required for this development appears to assure a large volume of traffic upon completion of the project.

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[18] This is now the world's largest cement mill. *Detroit News,* March 19, 1949, p. 5.

[19] Morrison, *op. cit.* (see note 17), p. 52.

[20] Included in Detour, Michigan, in the *Annual Report of the Chief of Engineers.*

RECEIVING PORTS

At five major ports lying along the industrialized Detroit and Saginaw rivers (Fig. 5) the receipts by lake carrier in 1947 were over one million tons. The four ports along the Detroit River and its tributary, the Rouge — Detroit, Rouge River, Ecorse, and Wyandotte — are regarded as separate entities, although the *Annual Report of the Chief of Engineers* includes them all as parts of the Port of Detroit. Differences in character of traffic, availability of statistics, and common recognition of each of the places are factors for identifying them separately. In contrast, the Saginaw River is considered here a single port, although since 1938 the *Annual Report* has provided tonnage data for six points along this stream. Inasmuch as all lake traffic must focus on the mouth of the Saginaw River and as three of the places are unincorporated and little known, it appears desirable to treat the group as a unit.

Along the American shore of the Detroit River is an eighteen-mile frontage which is accessible to the largest vessels plying the Great Lakes. With industry so important in the Detroit metropolitan area, it is natural that much of this riverine land, which extends from Belle Isle to the Trenton turning basin, would be in use. The four major receiving ports which lie along this busiest of commercial waterways occupy all but the five southernmost miles of shoreline. In 1947 approximately 125 million tons of commodities passed along the Detroit River, with close to 18 million tons of this total moving through ports along the American shore. At the four major receiving ports the aggregate receipts were nearly 16.6 million tons and shipments were over 0.7 million tons.

The Rouge River, not to be confused with or limited to the city of River Rouge, is an industrialized watercourse with two mouths through which passes close to one half the tonnage of the four ports (Fig. 5). The channel from the natural mouth of the Rouge to the Ford Motor Company has been used by vessels since 1918 and the route by the Short Cut Canal since the early twenties.[21] From the Detroit River to the head of navigation by way of the latter course is three miles. Although the lower one and one-half miles of the original channel is no longer followed by vessels en route to upstream points, it continues to serve many industries that use lake transportation.

Industrial activity began at the mouth of the Rouge in 1895 with the establishment of the Solvay Process Company to utilize salt beds under

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[21] Larson, R. H., "Dearborn in the First World War," *Michigan History Magazine*, 27 (1943): 308.

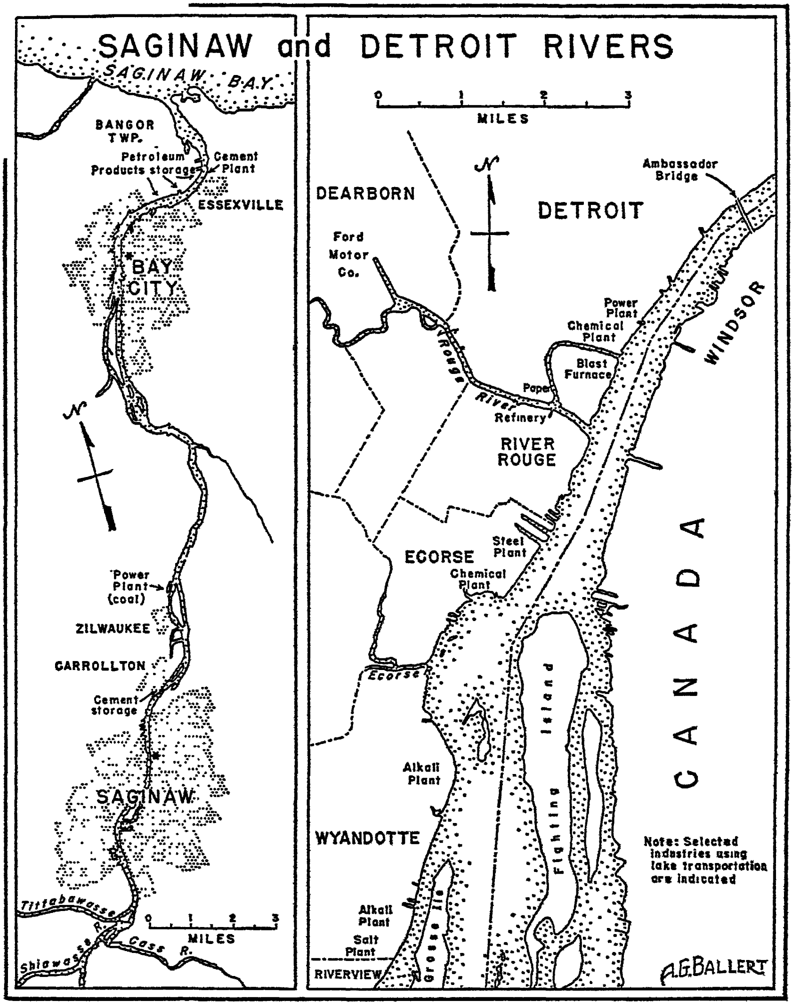

FIG. 5. Major receiving ports of Michigan

Zug Island. In 1902 the first coke iron furnaces in Michigan were started on the opposite side of the river entrance (Pl. III).[22] Subsequent expansion has developed along many lines, but nearly all the principal activities with frontage on the Rouge use one or more of the commodities which arrive by lake vessel. Iron ore and coal each represented over 30 per cent of the receipts in 1947 (Fig. 3). This is the only Michigan port which receives iron ore, and the only port on the Great Lakes which receives lake coal (from Toledo) throughout the winter. Other important receipts are limestone and gypsum rock, petroleum products, pulpwood, and sand. Two products of the port, rock salt and coke, comprise most of the outbound traffic.

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[22] Burton, C. M. and M. A., *History of Wayne County and the City of Detroit, Michigan* (Chicago, 1930), II: 1327.

The port of Detroit as considered here is the Detroit River frontage of the city of Detroit, but if corporate limits defined the port over three miles of Rouge River frontage would be added. Single commodities are dominant in the receipts, and shipments of the port as coal, nearly all bituminous, represented 85 per cent of the inbound tonnage in 1947 and, appropriately, the outgoing tonnage was 98 per cent automobiles and trucks. Transportation of the latter commodities, largely to Cleveland and Buffalo by converted bulk lake carriers, is the largest merchandise traffic on the Great Lakes, excluding car-ferry services. Also, the 6,600 tons of vehicles exported from the port represented a large portion of the all-water overseas trade from Great Lakes ports in 1947. Another type of water commerce, although not included in the tonnage of Detroit, is the river car-ferry traffic. In 1947 the shipments of this railroad freight eastbound were 8.4 million tons and the receipts were over 4.4 million tons.

Downstream from the Rouge River are the ports of Ecorse and Wyandotte (Fig. 5), whose traffic reflects the activities of their industries. The former port is dominated by the steel industry, while at the latter chemical production is outstanding,

Ecorse easily places first among the Great Lakes ports in receipts of iron and steel and, with a volume of nearly three quarters of a million tons in 1947 (Fig. 3), it represented about two thirds of the tonnage received. The location here of terminal facilities for the transportation line which brings much of the water-borne iron and steel to the Detroit area and the mills of the Great Lakes Steel Corporation explains this high volume. The latter organization is the only merchant steel producer in Michigan. Although it is a completely integrated plant, the lake traffic includes no iron ore, since the blast furnaces are but a short distance away on the Rouge River.[23] Limestone and fuel oil are other sizable receipts, but outbound tonnage is minor.

The principal industry of Wyandotte, which lies along a side channel of the Detroit River, is truly a product of the natural environment, for under it are great salt beds. Development of this area began in 1889, and since then expanding uses of the resource for chemical products have brought Wyandotte to a position of national importance. The lake receipts in 1947 were about equally divided between limestone and bituminous coal. The former commodity is used in soda products, which in turn furnish all the outbound traffic of the port. Adjacent islands in the Detroit River afford a place for the disposal of waste from the chemical plants.

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[23] In 1947 the annual capacities of the blast furnaces and open-hearth furnaces were 1,100,000 and 2,050,000 net tons respectively.

South of Wyandotte is Trenton, which is separated from the main channel of the Detroit River by Grosse Ile. This port's traffic, which totaled about one-half million tons in coal and petroleum products in 1947, is inadequate to place it with the major ports.[24] In the future, however, the McLouth Steel plant, now under construction, will utilize lake transportation sufficiently to place Trenton in this group. The site of the company's development occupies a full mile of river frontage.

No port on the Great Lakes reaches so far inland as the scattered docks along the Saginaw River, here regarded as a single port (Fig. 5). Although the Government channel extends upstream to the turning basin at Saginaw, a distance of nearly twenty miles, the greater portion of the total lake traffic is handled within two miles of the river mouth.

Long before the Saginaw River reached the status of a major receiving port in 1930 it had developed as an important shipping center. Leadership as a lumber port in the 1850's resulted from the river's being the focal point of the largest drainage basin in the eastern Lower Peninsula. This activity continued high for several decades, and as it declined another resource of the area, coal, bolstered the port traffic for a few years.[25]

The coal movement was far different in 1947, for this commodity then represented over 52 per cent of the receipts along the Saginaw River (Fig. 3). Other significant inbound tonnage was limestone, 23 per cent of the total, and petroleum products, 19 per cent. A cement mill at Essexville uses a major portion of the limestone, while petroleum products, particularly gasoline and fuel oil, are stored in large volumes across the river in Bangor Township. The latter group normally accounts for all the lake shipments of the port.

The Saginaw River has shown the greatest relative increase in lake tonnage between 1927 and 1947 of all major receiving ports of Michigan (Fig. 2). Increasing utilization of its excellent geographic position for serving interior points has been a significant factor in this growth.[26] Also, it appears that industrial expansion in the peripheral zone of the Manufacturing Belt (the Saginaw River lies at the northern border) has fostered the increase in tonnage.

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[24] The petroleum refinery here is the largest in Michigan.

[25] Coal shipments were made from 1894 to 1902. In the peak year, 1901, the volume was 645,000 tons. Data taken from issues of the *Annual Report of the Chief of Engineers*.

CAR-FERRY PORTS

Along the east shore of Lake Michigan are three ports, Ludington, Frankfort, and Muskegon, which together handle all the translake car-ferry traffic, a service which is widely accorded world leadership in this field of activity. Routes from these ports extend to five points along the west lake shore between Milwaukee, Wisconsin, and Manistique, Michigan (Fig. 1).[27] Each of the eastern termini handles more than a million tons of railroad freight by their car-ferry routes, and Ludington and Muskegon have additional traffic by lake bulk carriers.[28]

The car ferries, which operate throughout the year, transport many passengers and motor vehicles as well as railroad equipment. Capacities of these vessels range from 20 to 34 freight cars and from 15 to 50 automobiles.

Drowned river-mouth "lakes," of which there are ten along the western side of Michigan's Lower Peninsula, provide sites for all the car-ferry ports.[29] Early in the lumbering period it was recognized that these sand-dune-blocked estuaries could be developed into perfect landlocked harbors by straightening and deepening the natural outlets. With this done, commerce flourished on all the estuary lakes for a time, but only those which became car-ferry ports now have large tonnages.

The car-ferry routes are all operated by railroads which serve Michigan, and thus they are virtually extensions of these rail lines to meet the western roads (across-lake mileage is computed the same as all-rail mileage in making freight rate scales). The Michigan lines are all portions of rail systems which extend eastward from the state and which, therefore, are in a position to contribute to the east-west traffic via Lake Michigan.

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[26] Saginaw Bay extends the advantages of low-cost lake transportation fifty miles into the land mass of southern Michigan.

[27] These routes range in length from 60 miles (Ludington to Manitowoc) to 97 miles (Ludington to Milwaukee).

[28] The reader may wonder about the car-ferry traffic at the Straits of Mackinac, but in 1947 the totals were 263,319 tons northbound and 448,257 tons southbound. This was the first such service on the Great Lakes, having been established in 1888.

[29] For the formation of these features see O. F. Evans, "Origin of the Coastal Lakes of Western Michigan," *Geog. Rev.,* 27 (1937): 136–137.

With all the translake railroad traffic passing through the three ports considered here, their aggregate figures provide a complete check on the volume and character of this movement. In 1947 the ferries carried 5.9 million tons across the lake.[30] Receipts at the eastern Lake Michigan ferry ports represented 58 per cent of the total flow, whereas in 1927 they accounted for 47 per cent. Over the twenty-year span the traffic increased 22 per cent in volume. This gain has resulted from a marked rise in total receipts which has more than offset a minor loss in the total shipments. At all three ports receipts now are greater than shipments. The leading commodity shipped from the car-ferry ports is coal. In 1947 the volume from the three ports was over three quarters of a million tons and represented 32 per cent of the total outbound traffic; general merchandise accounted for 24 per cent of the total. This latter group comprised 31 per cent of the receipts. Forest products and agricultural products also are important in eastbound traffic.

Ludington ranked first among the Great Lakes ports in car-ferry traffic in 1947, handling about one half the total volume moving across Lake Michigan.[31] This port is on Pere Marquette Lake, named after the missionary-explorer whose grave was originally here. The early settlement along the embayed river mouth and the railroad which terminated here in 1874 also bore his name.[32]

Translake service from Ludington was introduced by the railroad in 1882, but not until 1897 were car ferries established.[33] Routes now extend to the three ranking car-ferry ports on the west side of Lake Michigan (Fig. 1). Ferry slips and rail yards occupy much of the usable water front, and together they provide the largest employment at the Ludington termini of these routes (Fig. 6). Ruins of a number of lumber piers on the east side of Pere Marquette Lake give evidence of the commercial

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[30] Included are the automobiles of travelers, but this traffic is only about 55,000 tons, or 31,000 cars, in each direction. Other pertinent figures for 1947 are:

	Eastbound	*Westbound*
Total traffic (tons)	3,443,187	2,461,988
Railroad cars (number)		
Loaded	127,432	82,766
Empty	18,292	31,261
Passengers	98,735	99,376

[31] Milwaukee competes with Ludington for the top position from year to year. Car-ferry services also operate across Lake Erie and Lake Ontario.

[32] This is now the Pere Marquette division of the Chesapeake & Ohio Railway.

[33] Jansson, A. H., "Great Lakes Carferry Service Expanding," *Marine Engineering and Shipping Review,* 41 (1936): 200.

importance of this activity in the past. The narrowness of the strip of dune land which separates this lake from Lake Michigan prevents any development on the west lake shore.

Two commodities which comprised over one half of the tonnage shipped from Ludington in 1947 were coal, 40 per cent, and salt, 13 per cent. Whereas the former product comes from the distant Appalachian fields, the latter is a resource of the hinterland. Merchandise represented a fifth of the shipments and a third of the receipts, while varied agricultural products accounted for another third. Lake-carrier traffic was solely receipts, with coal and limestone the principal items (Fig. 3).

Frankfort was the initial car-ferry port on Lake Michigan, having been established in 1892, shortly after the Ann Arbor Railroad had reached the shores of Lake Betsie. This lake, originally known as Aux Becs Scies, is the broad lower course of the Betsie River. Lake vessels are restricted to the car-ferry slips on the south side of the lake and to the commercial harbor directly northward, since the remainder of the lake is generally shoal (Fig. 6). Although the peninsula between the river-mouth lake and Lake Michigan is relatively wide, the use of it is restricted by broad, high dunes. The village of Elberta, formerly an iron-manufacturing town, and the Ann Arbor Railroad yards occupy the narrow shore strip to the lee of these dunes.

Operations of the railroad and car ferry are the principal activities of Frankfort except for the seasonal tourist business and the marketing of fruit. The chief asset of this port is its position for serving a transfer function on an established transportation route. For other commercial and industrial activities this is, in general, an adverse location.

Routes from Frankfort extend to all the western Lake Michigan car-ferry termini except Milwaukee. The two northernmost of these ports, Manistique and Menominee, have service only with Frankfort.[34] Thus this port has the broadest west-shore zone with which to exchange goods. The Ann Arbor has, however, but a single rail route across Michigan.

Receipts represented two thirds of the total traffic of Frankfort in 1947. About one third of the volume in each direction was merchandise; lumber and wood products accounted for another third of the receipts and coal for a fourth of the shipments. There is no lake-freighter traffic at Frankfort, the only million-ton port of Michigan or, in fact, of the Upper Lakes region which does not receive some coal by water.

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[34] The Manistique and Lake Superior Railroad is associated with the Ann Arbor Railroad and provides a service northward from Manistique.

The most versatile of the major ports is Muskegon. Although it is considered in this paper with the car-ferry ports, its lake-freighter traffic is well over a million tons. Located on the largest coastal lake accessible to freighters and car ferries and within the industrial zone of the state, Muskegon is the Lake Michigan lumber port which most satisfactorily met the decline in timber supplies. The thirty-four sawmills which bordered Muskegon Lake in 1887, the peak year in production, have all dis-

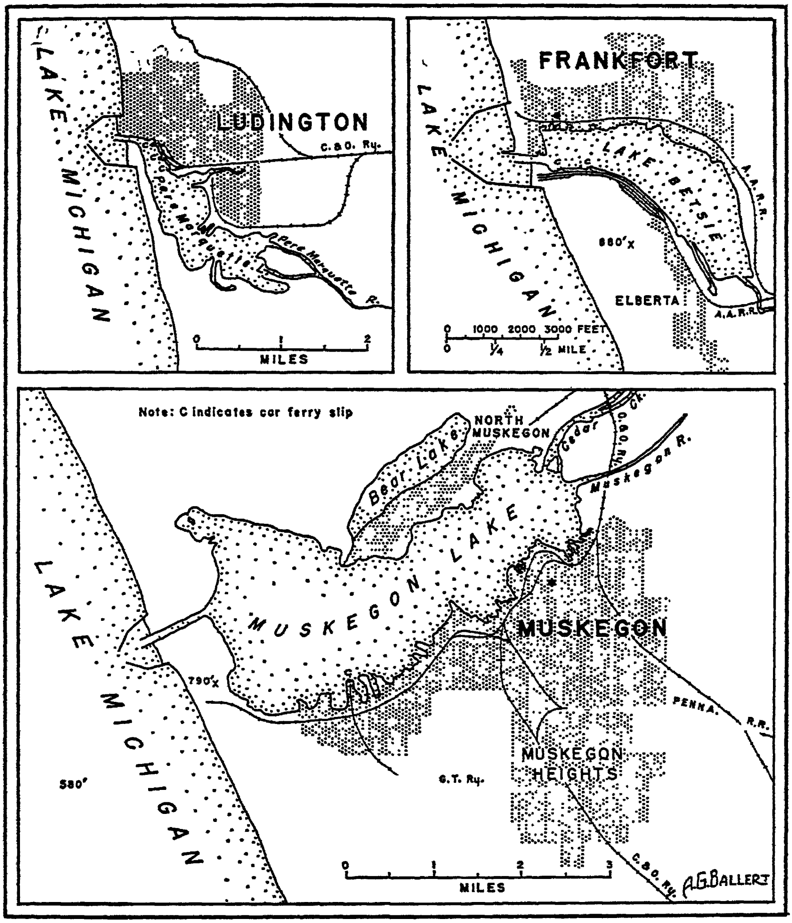

FIG. 6. The major car-ferry ports, which are located on drowned "river-mouth" lakes

appeared, but on the south shore industries, storage facilities, and wharves have replaced them. The significance of the port's relatively poor hinterland has been minimized by much local industrial development and by acquisition of the Grand Trunk–Pennsylvania car-ferry service from Grand Haven in 1933.[35]

Muskegon's ferry service extends only to Milwaukee, but the traffic on it has been over a million tons annually since 1940. Products of agriculture, particularly the various grains, represented over 40 per cent of the inbound traffic in 1947 while shipments were about two thirds manufactured goods. Because of the Grand Trunk's east-west rail pattern, coal played a minor part in the port's outbound traffic, only 15 per cent of the total. In contrast, the railroads serving the other car-ferry ports connect with the large coal-carrying roads at Toledo.

In addition to the car ferries at Muskegon, two other types of vessels provide cross-lake services. One is by the *Milwaukee Clipper,* a passenger ship which operates between Muskegon and Milwaukee except during the winter season. In 1947 it carried about 63,000 passengers east bound and 54,000 west bound and nearly 15,000 automobiles in each direction.[36] In other translake service a converted military vessel transports new cars between Muskegon and Milwaukee. The volume of this traffic is included with the tonnage of the regular lake carriers.

The bulk carrier receipts and shipments at Muskegon show a greater tonnage balance than that at any other principal port of Michigan, primarily because of the availability of molding sand near the outlet of Muskegon Lake. The resource is used in foundries and other industries and represented four fifths of the outbound tonnage in 1947. The volume of receipts exceeded shipments, with petroleum products constituting 45 per cent of this traffic. Other important inbound commodities are coal, cement, and pulpwood. A portion of each of these products is stored along the extensive water front (Pl. IV).

SUMMARY

In conclusion, it appears that Michigan will continue to have fourteen or more ports with an annual volume of traffic over one million tons. In view of the large reserves of iron ore and limestone the future of the shipping ports is assured for many years, but the acts of a few corporations can grossly affect the operations at these ports. Although changes in economic conditions are reflected most sharply in the tonnages of the shipping centers, with the exception of Rockport, all should maintain annual shipments in excess of a million tons. Prospects for continued growth in tonnage appear most favorable for Michigan's receiving ports. Expanding industrialization in the southern portion of the state, such as the development mentioned at Trenton, may give several more ports a million-ton status in the next few years. Furthermore, a number of additional commodities may well be transported via the Great Lakes as the maturity of this region takes place. Car-ferry traffic may have reached its peak in the early postwar years. Increasing use of highway carriers is a deterrent to further expansion of railroad traffic, particularly for manufactured goods, and such products are especially significant in the westbound car-ferry traffic. Muskegon, unlike the other car-ferry ports, has only a minor dependence on such service, its prospects being more akin to those of the receiving ports. An analysis of the character of the traffic of Michigan's major ports suggests that no marked change will occur at them if the St. Lawrence Seaway becomes a reality.

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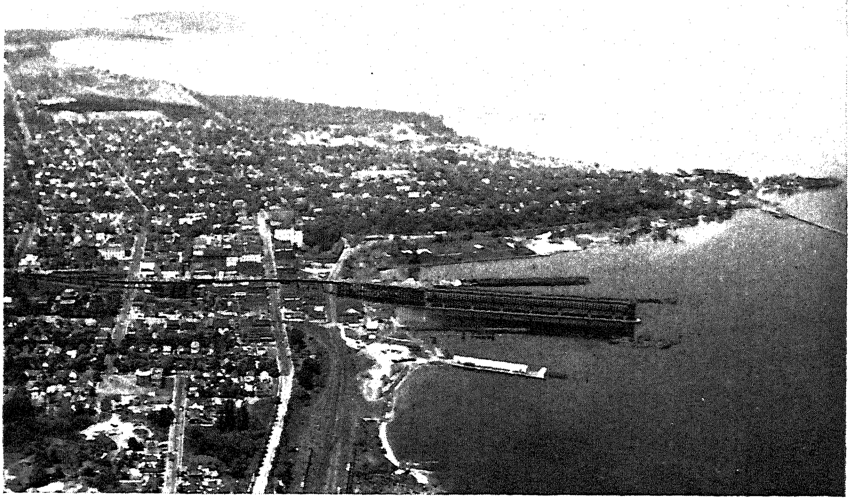
[35] From 1897 to 1906 the Chicago and Western Michigan Railway operated a car ferry between Muskegon and Milwaukee (Kline, H. V. B., Jr., "The Minor Cities of Lake Michigan," unpublished Ph.D. dissertation, University of Wisconsin, 1941, p. 138).

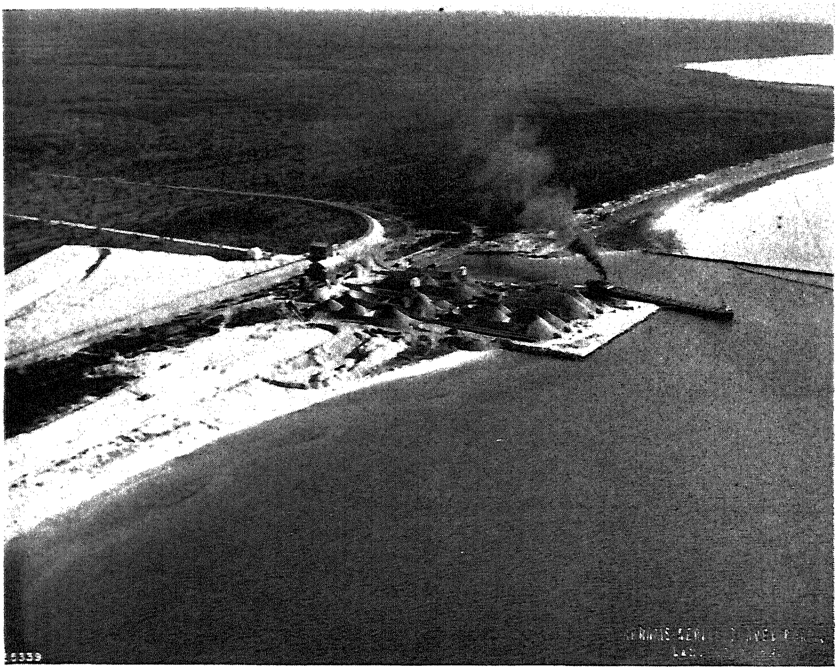
[36] Letter from Mr. Robert S. McKee, Wisconsin & Michigan Steamship Co., June 9, 1949.

MICHIGAN DEPARTMENT OF ECONOMIC DEVELOPMENT
LANSING, MICHIGAN

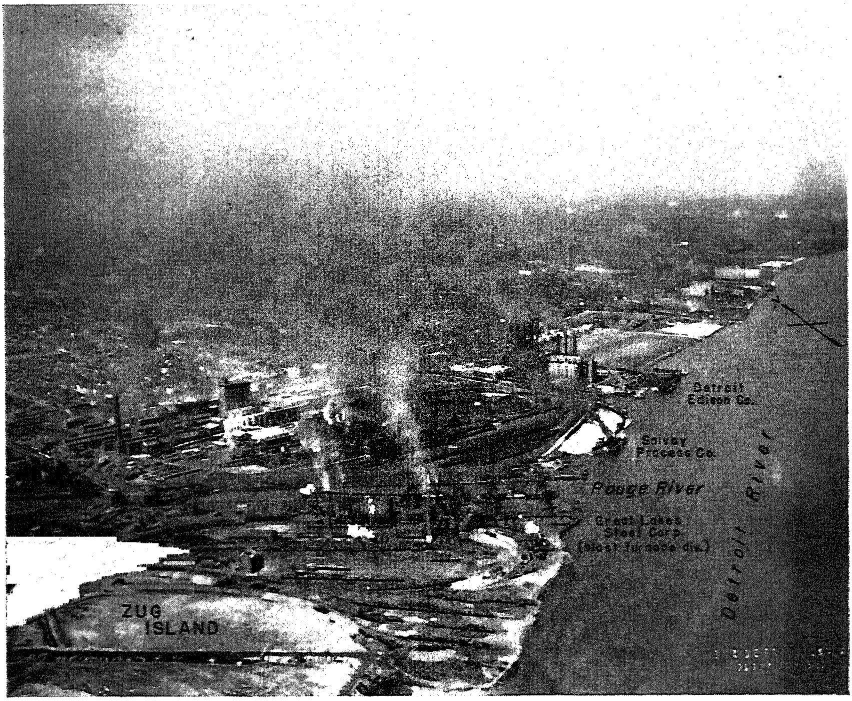
PLATES I–IV



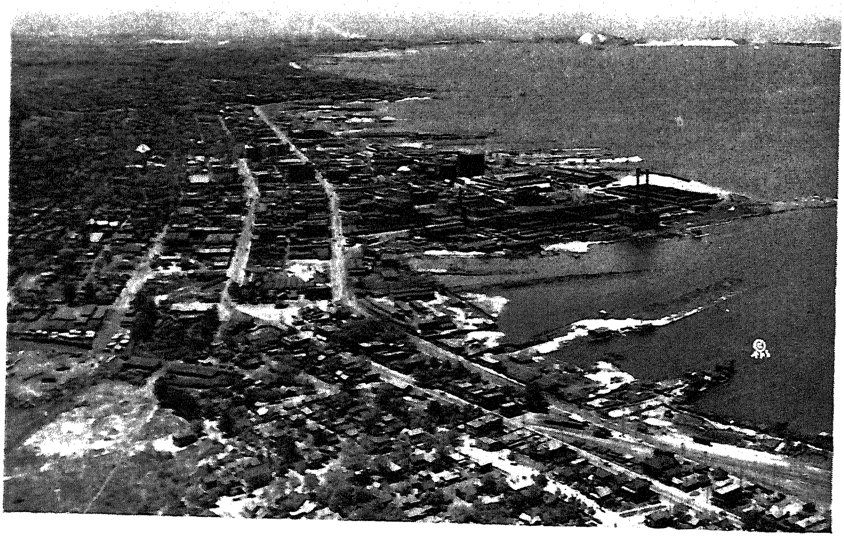
Air view of Marquette, looking north. Marquette Bay and ore docks in foreground; Presque Isle docks in background. (Courtesy of the Marquette Chamber of Commerce)



Port Inland, looking northeast. A second-growth wilderness lies behind this port. (Photograph by the Abrams Aerial Survey Corp., Lansing, Michigan; supplied by the Inland Lime and Stone Co., Manistique, Michigan)



Industry concentrated at the mouth of the Rouge River
(Courtesy of the *Detroit News*)



Muskegon, looking toward Lake Michigan in the background
(Courtesy of the Muskegon Chamber of Commerce)

THE ELECTRIC-LIGHT AND POWER INDUSTRY OF MICHIGAN

RAYMOND K. CASSELL

THE twentieth century has witnessed world-wide growth of national and regional plans of electrical-power generation and transmission; and within continental United States development has been intensive. The State of Michigan is included in a regional unit of the United States in which the concentration of production of electrical energy is the most pronounced. This comparatively small region, known as the North-Central Power Province, furnishes more than 30 per cent of the total output of the nation. The nature and the capacity of the production and distribution of electrical energy in the State of Michigan are to be considered in this paper.

The Detroit Edison Company and the Consumers Power Company are the major producers within the state, and three important outside companies (Indiana and Michigan Electric Company, Wisconsin Michigan Power Company, and Lake Superior District Power Company) transmit large blocks of power to Michigan consumers situated along the western margins of the state. Michigan normally furnishes about a quarter of the kilowatt-hours produced in the North-Central Power Province. Nationally, New York, with generating capacity of 5,500,000 kilowatts, held the number one position in 1947, with Michigan ranking sixth with a capacity of 2,500,000 kilowatts.

DEVELOPMENT AND CHARACTERISTICS OF THE INDUSTRY

Before the end of the first decade of this century it could fairly be said that there was no electric-light and power industry in Michigan. To be sure, electrical energy was produced, but not as a commodity for sale. The early days of generation for illumination and power in small private industries were followed by a period devoted to invention and exploration of methods for the large-scale generation and distribution of electricity.

Coincidental with this period was the era of expansion of the manufacturing industries in southern Michigan. It was the growing demand for electrical energy as the source of power in them which helped Michigan to become a principal power producer; likewise, the development of electricity as a major motive force fostered the growth of the manufacturing industries. Within the factory the mechanical transmission of power in the form of the line-shaft drive was taken over by the much more easily regulated, safe, and economical electrical transmission of motive force. The advance in the field of design and application of electrically operated apparatus to the countless forms of machinery has all but precluded other types of motive force, and it accounts for the fact that 69 per cent of the 12,993,000 kilowatt hours generated in 1948 was consumed by manufacturing industries.

Throughout the years of development of the electrical industry the demand periodically increased so much that occasionally the industry was called upon to supply more electricity than was safely available. Because electrical energy cannot be stored, generating plants must be large enough to supply power in amounts equal to peak-load requirements. Furthermore, in order to guarantee a firm supply, and to be able to meet emergencies, it is producer policy to provide a plant with 15 per cent more generating capacity than is required of it during the peak-load periods. It is this margin of reserve between load and capacity[1] which has helped to meet the increasing demand, and many times this margin has been dangerously small. Hence warnings have been sent out about power shortage, and the larger consumers have been asked to shift periods of maximum consumption to off-peak hours.

Generating plants now under construction and new plans in progress warrant hope of substantial increase in power supply. In Detroit alone by the end of 1951 generating capacity will have been increased by 400,000 kilowatts. Temporary power shortage will continue in northern Michigan as long as hydroelectric plants are not supplemented by steam generators.

In Michigan the regional supply pattern (Fig. 1) roughly follows the economic divisions of the state. The concentration of generation, produced almost entirely by steam in the largest plants of the Midwest, is along the water front of metropolitan and suburban Detroit. Though the map shows wide areas without generating capacity, it indicates the transmission system by which power is distributed over the state. The scale of the map prevents portrayal of the highly involved transmission system both above and below ground in the Detroit area.

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[1] Data on generating capacity are almost always shown in terms of manufacturers' "name-plate rating" — the capacity which the manufacturer will guarantee. Usually, owing to differences in operating conditions, or to modification after installation, the actual capacity is quite different from, mostly higher than, the name-plate rating. This unrecorded capacity, together with the fact that most generators are capable of carrying considerable overload for a brief time, has more than once prevented derangement of service during the periods of short supply.

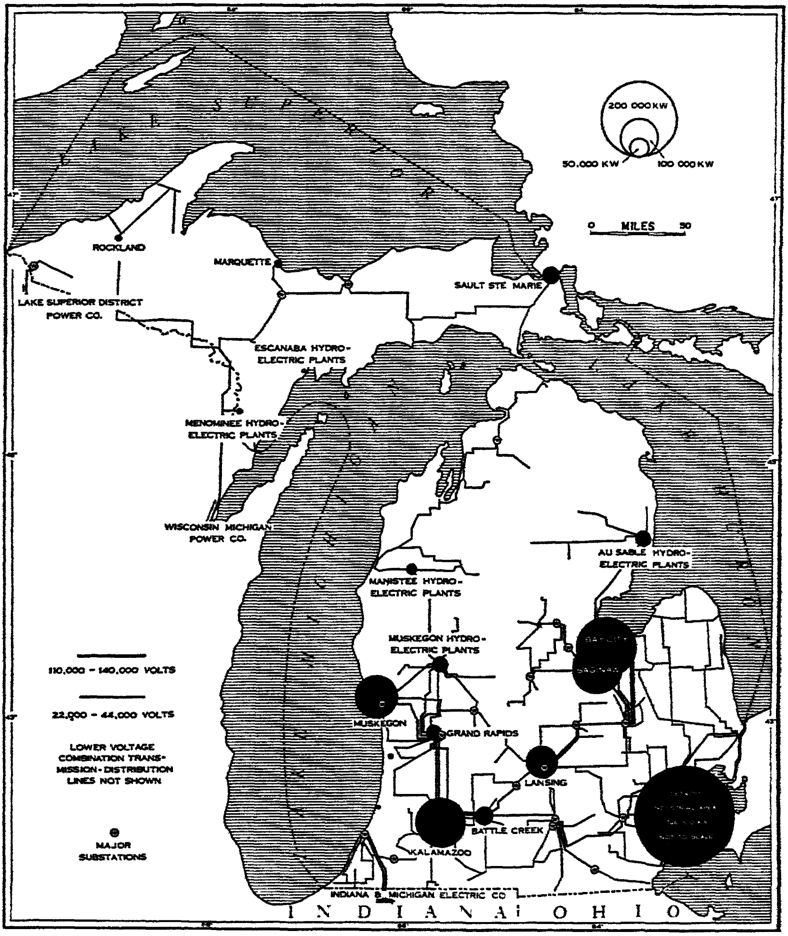
L A K E S U P E R I O R
200 000 KW
50,000 KW
100 000 KW
0 MILES 50
ROCKLAND
MARQUETTE
SAULT STE. MARIE
LAKE SUPERIOR DISTRICT POWER CO.
ESCANABA HYDRO-ELECTRIC PLANTS
MENOMINEE HYDRO-ELECTRIC PLANTS
WISCONSIN MICHIGAN POWER CO.
AU SABLE HYDRO-ELECTRIC PLANTS
MANISTEE HYDRO-ELECTRIC PLANTS
MUSKEGON HYDRO-ELECTRIC PLANTS
BAY CITY
SAGINAW
MUSKEGON
GRAND RAPIDS
LANSING
BATTLE CREEK
KALAMAZOO
DETROIT INDUSTRIAL AREA
NOT TO SCALE
110,000 - 140,000 VOLTS
22,000 - 44,000 VOLTS
LOWER VOLTAGE COMBINATION TRANS-MISSION-DISTRIBUTION LINES NOT SHOWN
MAJOR SUBSTATIONS
INDIANA & MICHIGAN ELECTRIC CO
I N D I A N A
O H I O

FIG. 1. Generating capacity and electric transmission system of Michigan

The transmission lines of the several commercial companies are greatly augmented by the intricate systems of interstate and intrastate interconnection. Such tie-ups permit a company to purchase power needed at peak-load periods, at other times to dispose of surplus power, and to provide aid for neighboring companies in times of emergency.

The commercial producers supply electricity to only fifteen of the fifty-five municipal power companies. Most of the large cities operate generating plants and distribution systems, but they depend upon the utilities for major supply. Although the total capacity of most of the small municipal installations is less than 100,000 kilowatts, the individual plants are very important to the people of Michigan because they are located in areas not reached by the power lines of the large companies.

The industrial producers of electricity furnish the power and most of the distribution systems which service rural Michigan. Eighty-five per cent of the farms are now electrified. Those which do not have electricity are mainly of the submarginal, self-sufficiency type and, therefore, would be little benefited by it.

Up-to-date data upon the comparative cost of electricity in Michigan are not available, but summaries of statistics supplied by the Edison Electrical Institute, the Federal Power Commission, and the Detroit Edison Company permit several generalizations. For the state as a whole, both residential and industrial electricity costs are very close to the average national costs, and the cost of residential electricity in the Detroit Edison Company area is well below the national average. The sale of electricity throughout this decade has increased tremendously, with a resultant decline in the average price of kilowatt-hours sold. The rapid rise in the industry's postwar operating costs without enough rate increase to offset those costs has restricted utility stock earnings, so that in the near future, in spite of the scare caused by Washington's attitude toward privately owned utilities, the consumer may well expect an increase in rates.

INDIANA UNIVERSITY
BLOOMINGTON, INDIANA

THE BEAVER ISLAND FISHING INDUSTRY

FRED W. FOSTER
Michigan State College

JOHN H. McMURRY
University of Michigan

INTRODUCTION

THE waters surrounding the Beaver Islands provide some of the better fishing grounds of the Great Lakes. The region has been noted for the productivity of its fisheries for more than a century, and Indians looked to it as a source of food long before the coming of the white man. The present population is composed chiefly of the descendants of early Irish emigrants, over half of whom are dependent on the fishing industry for their livelihood. It has become relatively more important as lumbering operations have exhausted the forests and farming has lost much of its commercial significance.

Most of the islanders believe that fishing cannot long continue to provide the major portion of their income. This opinion, based on years of observation, may hold a great deal of truth, but the season of 1947 was one of the best for whitefish in the memories of many inhabitants. While their conclusion is possibly influenced by a natural pessimism, there is no question but that the industry is undergoing a gradual change, which is resulting in the employment of fewer men and a reduction in the number of boats in service. The effect of these modifications on future catches cannot be predicted. It may be assumed, however, that a continued contraction of the industry will be influenced by many factors other than the dwindling fish population.

THE PAST AND PRESENT STATUS OF THE INDUSTRY

The general decline of the Beaver Island fishing industry is well illustrated by a comparison of present operations with those of fifty years ago. At the turn of the century the steam, sail, and gas boats of the fleet set its nets over the northern parts of Lake Michigan and Lake Huron, as well as over the connecting waters of the Straits of Mackinac. Six commercial docks on St. James Harbor engaged in a flourishing trade with the fishermen. Fish were bought, iced, packed, and shipped to the big urban markets of such places as Detroit, Chicago, and New York City. A brisk rivalry existed between St. James and centers on the mainland. Winter fishing with hook and line, spear, or gill nets set under the ice provided year-round occupation for the fishermen.

The picture is different today. The fleet of fifty to seventy-five vessels has dropped to eighteen or fewer. The last steam tug sank at its moorings in the Harbor during a storm in 1942. Operations, once widespread, are now limited to the bays, inlets, and reefs near at hand and among the neighboring islands. Summer fishing for trout and whitefish in the deep, cool waters of the lake has lost most of its importance, and winter fishing has all but ceased. Only two of the original commercial docks still function, and neither is devoted exclusively to the fish trade. There are a number of factors that may explain the changes that have taken place.

Records of the Michigan Department of Conservation indicate that, while there has been a decided increase in the value and amount of fishing gear used on the Great Lakes since 1925, the size of the catch has decreased. For the past ten years a combination of war and postwar high prices has maintained the value of this smaller catch at a higher level than usual. Thus the 1927 total of about 32.5 million pounds of fish was worth a little more than 3 million dollars, whereas the value of the 1945 catch of close to 24 million pounds exceeded 5 million dollars.[1] There is a probable correlation between these high prices and the fact that no reduction in the number of commercial fishing licenses issued in Michigan has occurred in this period.

As fish have become scarcer, many of the large commercial companies have intensified their methods by the use of better and more effective equipment. Owing to a combination of circumstances the Beaver Island fishery has not kept pace with others on the Great Lakes. An isolated position with respect to markets and a lack of interest in coöperative enterprises hampered efforts directed toward improvement. The islanders are extremely individualistic, and small triumphs over a neighbor bring more satisfaction than concerted effort to meet increased competition. As individuals they have failed to modernize their equipment. The use of the deep trap net, a major factor in the success of other commercial fisheries, has not been favored at St. James. It is a notorious fish killer, and the Beaver Islanders have considered its use unethical. In addition, cost and maintenance of the deep trap are great.

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[1] The Michigan Department of Conservation, *Fourteenth Biennial Report,* 1947, pp. 91–97.

The Beaver Island area was once the habitat of lake trout, which until recently constituted the chief product of the industry, but today this valuable species has almost disappeared locally. Fortunately, an increase in the number of whitefish has, in some measure, compensated for the lack of trout. However, smoked trout, an important source of income, has not been replaced by a similar whitefish trade of comparable importance.

The size of the fishing fleet operating among the Beaver Islands fluctuates from year to year. This is a reflection of the influence of many factors, which include the current market price, the size of the catches, the availability and cost of labor, and the weather. A few fishermen from Cheboygan, St. Ignace, Mackinaw City, and Cross Village occasionally come in for a season. Their numbers are limited by the distance and the traditional monopoly of the best grounds by local operators who sail from the harbor of St. James. It is estimated that on the average eighteen craft have docked at this point annually over the past five years, almost half of which were employed in gill-net fishing, with the remainder working trap and pound nets.

The fish population shows a cyclical fluctuation over a period of years. At an earlier time, when operating and equipment costs were less and the fishermen's incomes were supplemented by farming or by work in the lumber camps, a poor season was not so critical. At present few of those engaged in fishing have other sources of income, and a prolonged period of inadequate return may have serious consequences. During such times the fishermen may seek other employment, never to return to their nets, owing to the finding of more lucrative work or of positions which offer greater security. At times the cost of replacing worn-out or outmoded equipment may prohibit resumption of the activity. Under similar circumstances an owner of two or more vessels may keep only one in commission.

Increased labor costs are limiting the number of boats engaged in fishing, particularly in gill-net operations, in which three or four men constitute a crew. At its best the industry is a speculative enterprise, and a few unproductive weeks may absorb the profits of the rest of the season. While this condition has resulted in an increase of owner-operated boats, it has also brought about a decrease in the total number of vessels and a shift from gill to pound and trap nets. There are on the island a number of Indians who have replaced white workers as they sought other positions. They seem willing to work for relatively low wages, in an activity of irregular employment. With their passing it is doubtful if other labor will be forthcoming, and it may be expected that the number of boats in commission will show a further decrease.

Inclement weather may interfere with the setting of the nets and, if it continues for a protracted period, often results in a temporary abandonment of fishing. A depressed market can also influence this condition, since even good catches may give returns too small to pay the cost of operation.

The local consensus of opinion predicts a steady and continued decline of the industry among the Beaver Islands, but it would seem that this viewpoint is open to question. The answer can be found only by a careful analysis of the number of boats engaged and the total catch over a considerable period of time. For although economic and natural factors may periodically result in depression, the full-time fisherman is inclined to carry on as long as possible despite adversity. This is his trained field of employment; the chances for great profits are always present, and he works in an environment he is loath to abandon.

THE VILLAGE AND HARBOR OF ST. JAMES

(Figure 1)

The fishing activities of Beaver Island center in the village of Saint James, which is the extreme northeastern part of the island along the shore of a sheltered embayment known as Beaver, or Saint James, Harbor. The choice of this site was determined as much by the necessity for adequate port facilities for communication with the mainland as by the need of a suitable base of operation. Since, however, the livelihood of the inhabitants is dependent upon fishing, one finds docks, fish sheds, small boats, and other appurtenances of the calling dominating the water front.

The physical characteristics of the bay and shoreline are suited to the requirements of the fishermen. The entrance channel maintains a depth of at least five fathoms to a point close to the west shore, and a small depression of similar depth lies just to the north of it. The bar between them offers no hazard to craft with a draft of less than six feet. Shallows extend from the channel to the southern and southwestern extremities of the indentation. The depth of water over much of this area is not sufficient to carry even small boats, and it is not possible to lie close to shore. As a result, the fleet docks around the northern half of the bay, where wharves can be easily constructed to deep water.

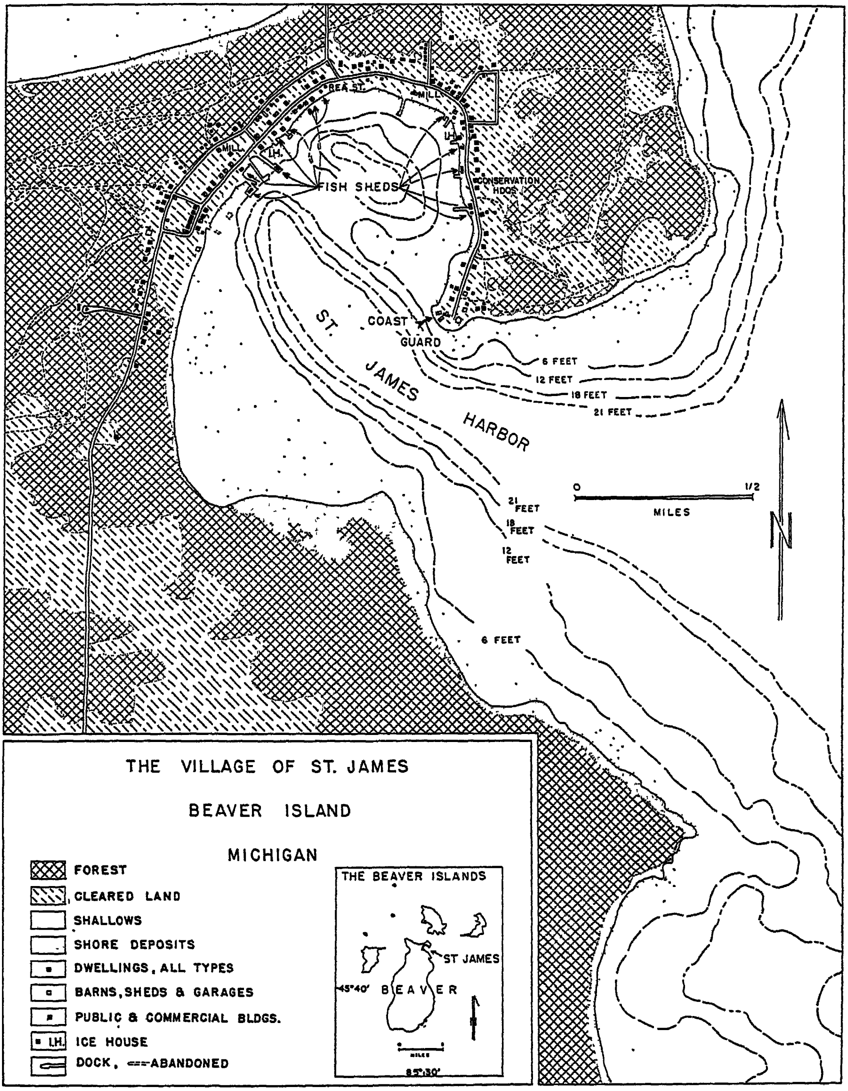

FIGURE 1

The immediate shore is but a few feet above the level of the bay. It is sandy or gravelly, for the most part, and provides a firm foundation for building. Sheds for storing equipment and handling fish, icehouses, and racks for cleaning and drying gill nets are scattered along the northern periphery of the embayment. They are associated with one or another of the many wharves to which they have easy access at about the same elevation. The nature of the strand allows boats to be hauled ashore for winter storage or repair with a minimum of effort. The area also provides good sites for boatbuilding and sufficient space to peel net stakes and spread nets. All the shore activities connected with fishing are concentrated within this narrow belt.

The village proper is situated on the terraced margin of a post-Nipissing sandy lake plain encircling the bay. The main thoroughfare of the settlement follows the outer edge of the lowest terrace, ten or fifteen feet above the present shoreline. The majority of the dwellings and commercial buildings are along this highway facing the water. This street is paralleled in discrete pattern by a second road, which runs along the edge of a higher terrace. The two join near the southern extremity of the town, from which they continue down the middle of the island as the King's Highway.

The commercial establishments serve the minimum needs of the people. Two general stores, a meat market, a restaurant, a garage, and two taverns meet the daily requirements. Other goods are ordered directly from the mainland, often by catalog. There are no commercial enterprises other than two wholesale businesses that cater to the fishermen, and none which furnish special services for the farmers. One of the two lumber mills makes packing boxes for the shipment of fish. Two summer hotels, a few cottages, a church, a school, a town hall, and a doctor's office complete the list of service establishments.

The bay and village are centrally located with respect to the fishing areas scattered among the surrounding islands. This position does not necessarily imply that a direct course can be set to the grounds, since numerous reefs and shallows may force a devious route of passage. The position and size of the harbor, the availability of good water front, and the protection offered from wind and waves make the location the only suitable base for extensive fishing operations among the islands of northern Lake Michigan.

MARKETING

Great Lakes whitefish and trout are shipped to all parts of the United States. Although the contribution of Beaver Island to such shipments cannot be determined, it represents a considerable part of the total. The bulk of the fish are handled from two commercial docks on the harbor. Individual fishermen, however, may sell their catches at Cheboygan, Mackinaw City, or Charlevoix. One operator sells directly to Chicago.

The uncleaned fish are placed in boxes of standard size. Whitefish, which are quite perishable, are packed, eighty pounds to a container, in two layers with ice between, above, and below. Trout are handled in a similar manner, but, being less perishable, are packed 120 pounds to a box, with ice at the top and bottom.

The major marketing problem facing the industry is the great discrepancy between the dock and the retail prices. This differential arises from the present necessity for immediate sale and a lack of organized effort on the part of the fishermen toward a solution of their marketing difficulties. Coöperative effort, with the control of processing and marketing facilities in the hands of the fishermen, offers a possible solution. Extensions of such a plan might include the application of quick-freezing techniques during certain seasons of the year, the shipment of cleaned rather than ungutted fish, and sale under brand names.

FISHING TECHNIQUES AND NET TYPES

Successful fishing depends, to a greater extent than ever before, upon the efficient application of a variety of skills and techniques. The high cost of gear demands the maximum use of every piece of equipment. The fishermen must be able to diagnose motor trouble and repair engines, often under trying circumstances. The making and mending of nets, the building and repair of boats, an understanding of practical navigation, weather-forecasting ability, and a keen appreciation of the habits and ecological associations of fish are but a few of the numerous arts and crafts in which proficiency must be developed. There are not many types of employment in which success depends as much upon the mastery and application of a wide variety of skills as it does in the fishing industry. The object of the fishermen is to set the proper type of net in the correct place at the right time.

The gill net is the least expensive and most easily handled of all the net types now in commercial operation. Its chief advantage lies in its mobility and adaptability. Since it is light it can be lifted or set in a matter of minutes, and it can be used over many types of bottoms. It is possible with this net to try a variety of grounds in search of one which is currently productive or to take advantage of runs of short duration. Disadvantages connected with the special equipment used for handling the nets are the need for a greater labor force and the necessity for lifting the nets at least every other day.

The average gill net is from three to five feet wide and fifty to seventy-five yards long. Floats along the top and lead weights at the bottom keep it erect when submerged. The net is fixed in place by an anchor at either extremity. Its position is indicated by flagged buoys bearing the license number of the owner. In large-scale operations fifteen to twenty nets may be joined and set as a gang or string. When this is done by many boats in restricted waters, crossing and fouling may result in a great deal of damage. The losses incurred from this type of damage are often responsible for considerable ill feeling among the fishermen.

The pound net is becoming increasingly prominent with each succeeding season. There are many advantages in its use which are important to the average fisherman. But two men are required for its operation. It may be permanently located for any part of a single season and is reset only to take advantage of better fishing. The fish remain alive, and the interval between visits to the net can be adjusted to the volume of the catch as well as to periods of favorable weather.

The pound net is the largest and most bulky piece of equipment used by the Beaver Island fishermen. It is designed to take advantage of the habit of fish working along the shallows over a reef close to the shore to seek deeper water when an obstruction bars their path. The lead, a straight net 300 to 900 feet long and six to eight feet wide, serves this purpose. It is supported by a line of stakes driven perpendicular to the axis of the shoal, or at right angles to the shore, and leads to the deeper water. Its bottom is held to the floor of the lake by stones, and the top is supported at the surface by large air-filled cans. The fish pass through a narrow gate into a large tunnel at the deep end of the lead, where they are funneled into the gate by two wings located at each side of the entrance. The tunnel is from twelve to fifteen feet around at the point of entry, and gradually narrows to an inner circumference of one or two feet. On emerging from the tunnel the fish swim about in a large square enclosure called the pot, congregating on the side toward the deepest water. They rarely find the small tunnel opening in attempts at escape. Further protection is afforded by a small-mesh net covering the top of the pot. The entire net is supported and held in position by fifteen to twenty stakes driven into the lake bottom.

The function and design of the trap net are essentially the same as those of the pound net. The chief difference lies in the fact that the trap net is much smaller and is set with anchors and floats rather than with stakes. Thus it has greater mobility than the pound net and can be easily moved from one position to another as the occasion demands. Its main disadvantages are that it holds fewer fish and is subject to greater damage by storm.

CONCLUSION

There has been an evident reduction in importance of the Beaver Island fishing industry for a good many years. The number of men and boats engaged in it has steadily diminished, and the total catch has become smaller with each succeeding season. The industry has assumed a seasonal aspect with the use of trap and pound nets in the shallower waters during the heavy fall and spring runs. The prosperity of the remaining fishermen has been maintained by the higher prices of the war and the postwar periods. With a return to more normal economic conditions, and with continued decrease in the fish population, the wide gap between dock and retail prices will become an even greater critical problem. Some of the more optimistic fisheries specialists believe that the present scarcity represents a low point in the cycle of abundance. An analysis of the Beaver Island fisheries based upon present-day conditions tends, however, to indicate a further decline in their prosperity.

THE COACHELLA VALLEY, CALIFORNIA

SOME ASPECTS OF AGRICULTURE IN A DESERT

ROBERT M. GLENDINNING

TRULY arid regions are difficult to settle and equally difficult to maintain as human habitats after the initial settlement, and the Coachella Valley, part of the Colorado Desert, is no exception. It is the northern section of a large trough which extends from the Gulf of California to the San Gorgonio Pass, between the San Bernardino and the San Jacinto Mountains, about ninety miles east of Los Angeles (Fig. 1). It is nearly closed at the Pass end and is open at the opposite end, where it meets the shallow waters of the Salton Sea. It may be most simply described as a mountain-walled desert trench (Figs. 2–3).

Why the Coachella was originally settled by a few primitive Indians and why it is at present occupied by white men in far greater numbers is something not easy to understand, especially since much more hospitable lands were readily available in the coastal area, and available at a time before the pressure of white population in the Los Angeles region had begun to encourage production in desert areas near by. Yet the Coachella has been settled, and its development is now proceeding faster than ever before.

The Indian impress is comparatively negligible. Before the advent of the white man a handful of Indians lived at the margin of the valley or on the valley floor proper, either at potable hot springs or around shallow pitlike wells of their own digging.[1] Their contribution to the present scene consists mainly in ownership of reservation lands which appear here and there in the cadastral pattern as separate and incomplete checkerboards comprised of square-mile sections. The Indian holdings represent many square miles of land, but they contain few Indians. Moreover, they are areas of retrogression, rather than progress. The only exception to the former condition occurs in and near the famous resort of Palm Springs (Fig. 3), where rental of land and control of the hot springs and certain scenic terrain provide a life of ease for some seventy Indians. Far outstripping the Indian impress is that of the white man, especially the farmer, or "rancher"; it is his presence and accomplishments which strongly mark the modern scene, and they will continue to be most significant.

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[1] James, George Wharton, *The Wonders of the Colorado Desert* (Boston: Little, Brown and Co., 1911), esp. pp. 233–252.

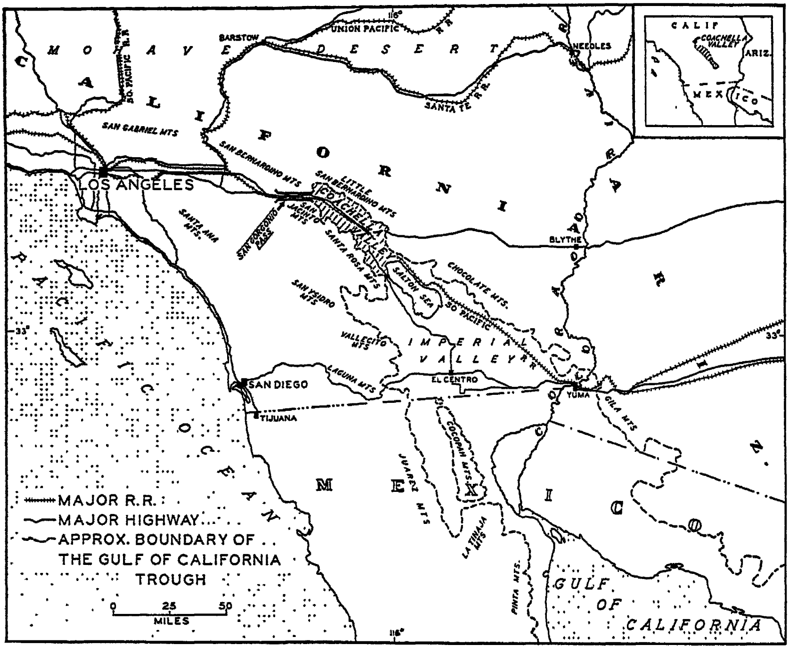

FIG. 1. General location map of the Coachella Valley

The use of the Coachella by white men is surprisingly recent, for the area was not crossed by them until 1853.[2] Within the next twenty-five years it was traveled intermittently by freight wagons and stagecoaches. They did not serve the region, but were merely trying to get through it as quickly as possible as they journeyed to and from the Los Angeles area and the crossings of the Lower Colorado River.[3] The Coachella proved so difficult, primarily because of the scarcity of water, windstorms, and long stretches of sand (Fig. 3), that a more circuitous route through the coastal mountains was usually followed. A railroad, a part of the present transcontinental line of the Southern Pacific, was pushed across the valley in 1879, but it likewise went through, instead of serving, the area, although it later proved of great local benefit.[4] Not until about 1900 did any considerable number of settlers take up the land

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[2] Williamson, Lieut. R. S., *Report of the Exploration in California for Railroad Routes,* 1853, 33d Congress, 2nd Session, Senate Executive Document No. 78, Vol. V, Washington, 1856. Because of the comparative recency of its discovery, the Coachella Valley, unlike much of California, lacks a "Spanish period" in its history.

[3] Beattie, George W., Beattie, Helen P., *Heritage of the Valley* (San Pasqual Press, Pasadena, Calif., 1939), esp. pp. 339–349, and also James, *op. cit.,* p. 258.

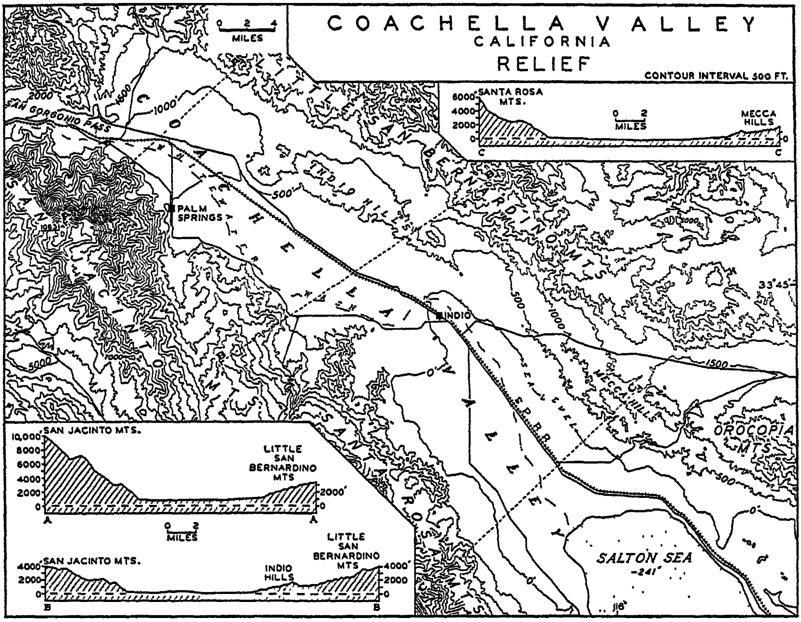

FIG. 2. Relief and typical profiles. The trenchlike character of the Coachella Valley is clearly proved by the profiles and the contour line pattern. The region from Indio to and including the Salton Sea is below sea level and the contour is 500 feet. The altitude difference between the present level of the Salton Sea and Mt. San Jacinto, the highest peak of the San Jacinto Mountains, is 11,072 feet and that between Mt. San Jacinto and the entrance to San Gorgonio pass is 9,831 feet (within a distance of six miles). (Map based on Palm Springs, Edom, Pinyon Well, Hemet Reservoir, Toro Peak, Coachella, Cottonwood Springs, Aqua Dulce, and Durmid quadrangles (California), issued in 1943–44, War Department, Corps of Engineers, U. S. Army, Grid Zone F. Scale 1 : 62,500, contour intervals variable)

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[4] *Historical Outline of Southern Pacific Company,* issued by Bureau of News, Southern Pacific Co., San Francisco, March, 1933.

TABLE I

COACHELLA VALLEY ACREAGE AND CROP REPORT FOR 1948

Variety of crop	Acreage				Season's yield	Valuation	
	Bearing	Nonbearing	Season's planting	Total		Rate	Total
CITRUS							
Grapefruit	1,859	85	137	2,081	598,600 boxes	$ 2.88	$1,723,968.00
Lemons	15	2	55	72	1,050 boxes	1.30	1,365.00
Miscellaneous	57	17	2	76	7,760 boxes	2.48	19,244.80
Tangerines	163	253	55	471	31,050 boxes	4.10	127,305.00
Valencias	84	7	4	95	18,530 boxes	2.50	46,325.00
DECIDUOUS							
Dates	3,432	1,366	69	4,867	22,933,820 lbs.	.18½	4,242,756.70
Cull dates	..	..	..	..	1,205,780 lbs.	.01½	18,086.70
Figs	17	2	..	19	1,820 lugs	3.36	6,115.20
Grapes							
Thompson Seedless	3,492	1,715	574	5,781	718,769 lugs	4.20	3,018,829.80
White Malaga	66	3	..	69	26,314 lugs	2.45	64,469.30
Red Malaga	48	..	13	61	6,480 lugs	4.70	30,456.00
Ribier	13	16	23	52	2,441 lugs	5.30	12,937.30
Cull grapes	..	..	..	..	1,062 tons	17.50	18,585.00
Pecans	31	..	..	31	4,880 lbs.	.60	2,928.00
TRUCK CROP							
Beans, green	1,221	..	..	1,221	114,774 crates	6.84	785,054.16
Carrots	323	..	..	323	66,550 crates	3.60	239,400.00
Celery	27	..	..	27	10,800 crates	2.00	21,600.00
Corn, sweet	3,736	..	..	3,736	398,375 crates	3.00	1,195,125.00
Cucumbers, Miscellaneous	16	..	..	16	3,200 lugs	1.30	4,160.00
Eggplant	233	..	..	233	196,500 lugs	2.00	393,000.00
Melons, cantaloupes	465	..	..	465	90,310 crates	2.70	243,837.00
Okra	124	..	..	124	58,900 lugs	1.40	82,460.00

Variety of crop	Acreage				Season's yield	Valuation	
	Bearing	Nonbearing	Season's planting	Total		Rate	Total
TRUCK CROP (*Continued*)							
Onions							
Green	92	..	..	92	3,680 crates	$ 1.15	$ 4,232.00
Dry	153	..	..	153	62,730 sacks	1.95	122,323.50
Peas	167	..	..	167	21,710 crates	6.80	147,628.00
Peppers							
Bell	332	..	..	332	49,800 crates	4.20	209,160.00
Chili	75	..	..	75	48,750 lugs	3.90	190,125.00
Potatoes, sweet	236	..	..	236	27,140 lugs	3.33	90,457.62
Spinach	481	..	..	481	134,680 crates	1.00	134,680.00
Squash							
Miscellaneous	339	..	..	339	88,835 lugs	2.20	195,437.00
Summer	174	..	..	174	26,100 lugs	2.25	58,725.00
Tomatoes, table	587	..	..	587	657,440 crates	2.45	1,610,728.00
FIELD CROP							
Alfalfa	1,959	..	..	1,959	9,794 tons	29.00	284,055.00
Beans, dry	214	..	..	214	1,070 sacks	6.50	6,955.00
Corn, Milo Maize	80	..	..	80	1,200 sacks	2.90	3,480.00
Cotton, Acala	2,211	..	..	2,211	3,022 bales	145.00	438,190.00
Flax	150	..	..	150	1,950 sacks	12.50	24,375.00
SEEDS							
Cotton, Acala	..	..	..	..	1,209 tons	70.00	84,630.00
Onion	5	..	..	5	2,700 lbs.	1.10	2,970.00
TOTALS	22,677	3,466	932	27,075			$15,906,159.08

and actually develop it. They succeeded in starting a modification which has changed a large portion of the Coachella from raw desert to one which in 1948 produced $16 million worth of fruit, truck, and field crops (Pls. I, VII; Table I). Lesser areas, chiefly upvalley from the agricultural section, have become important winter resorts (Pl. II), especially within the last fifteen years.

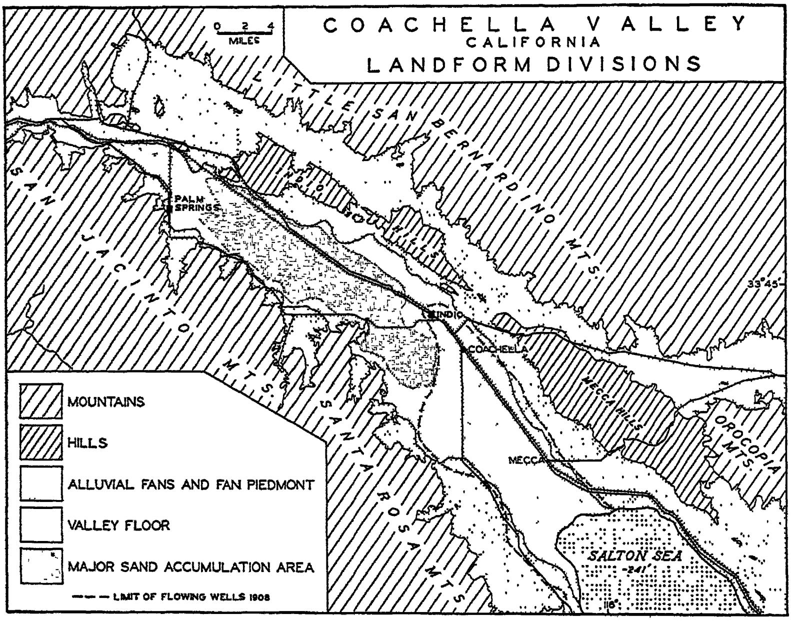

FIG. 3. Landform divisions. This map further emphasizes the trenchlike nature of the Coachella Valley shown on the relief map (Fig. 2); it also indicates how the structural depression is being filled with loose materials. There is an area of pronounced sand aggradation (also appearing on profile B–B of Fig. 2) within the part of the valley floor from near Palm Springs to Indio. The limit of flowing wells in 1908 is from map C–1K–110 (1947) of the U. S. Bureau of Reclamation Office at Coachella, Calif. (Landform divisions are based on the author's field work, aided by partial coverage of the region by aerial photographs made by Fairchild Aerial Surveys, Inc., Los Angeles, Calif., 1939)

As one contemplates the endeavors of the agricultural settlers and the results obtained by them, he may well say: "This is an instance of 'in spite of' and 'because of' — a settlement accomplished in spite of many adverse conditions and because of a few, but potent, favorable conditions." The ensuing discussion attempts to recognize the more salient of these conditions and their interplay.

One of the strongest factors against settlement was, and still is, extreme aridity. Although no more than sixty-five miles from the Pacific Ocean, the Coachella is as dry as much of the Sahara. Its aridity reflects a lee position in reference to a mountain wall which rises very abruptly from 4,000 to 10,000 feet above the western margin of the valley. This barrier almost completely modifies the effects of winter cyclones which water the coastal area. Furthermore, warm-season convectional storms over the valley itself are few, and they supply only meager and "spotty" rainfall. The amount of rainfall in the valley is indicated by the statistics for the town of Indio, in the midportion of the valley floor.[5] Its average annual precipitation is almost exactly three inches. The wettest year received about seven inches and the driest years only traces (Fig. 4). Such meager rainfall is rendered still less effective because of high temperatures and desiccating winds. The high degree of moisture defi-

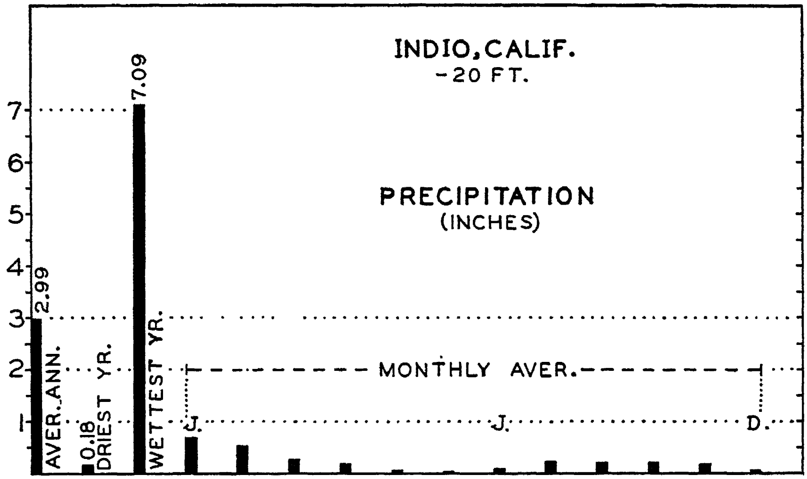

FIG. 4. Precipitation chart, showing the meagerness and variability of rainfall in the Coachella Valley. No month averages as much as one inch, and the average annual precipitation is slightly under three inches. (Chart based on data selected from Arthur F. Pillsbury, *op. cit.*, Table 1)

ciency can be realized when it is stated that potential evaporation is about twenty-six times the average annual rainfall.

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[5] Pillsbury, Arthur F., *Observations on Use of Irrigation Water in Coachella Valley, California* (Agricultural Experiment Station, University of California, Berkeley, Bulletin 649, 1941). See page 4 for the climatic summary for Indio.

A concomitant of scant rainfall and great evaporation is the lack of readily procurable surface water, for there are no native surface streams and there is not a single exotic stream, despite winter snow and lesser summer rains in the mountains. A sidelight on the arid condition is the fact that as recently as 1920 the Government issued a desert guidebook for the use of travelers in this region.[6] The first part of the detailed road log of this booklet deals with the Coachella.

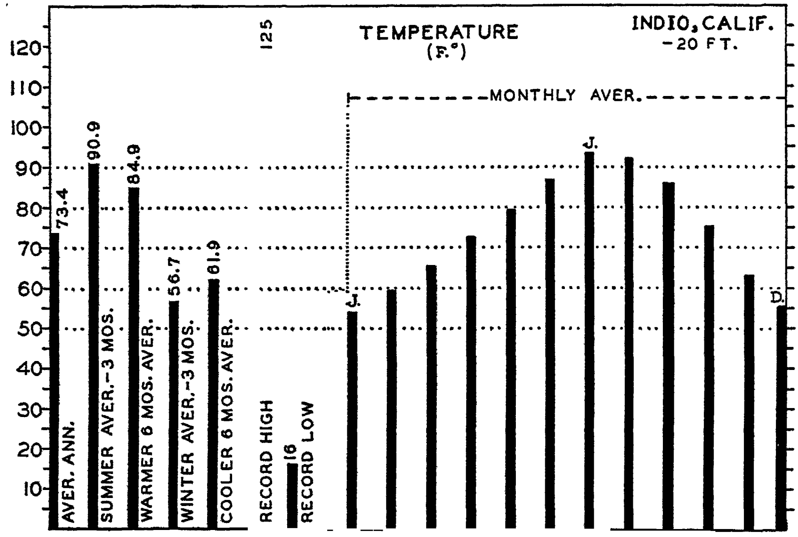

FIG. 5. Chart showing the temperatures that help to make the Coachella Valley the "date capital" of the United States as well as insure the heat necessary for year-round production of many types of crops. (Chart based on selected data from Arthur S. Pillsbury, *op. cit.*, Table 1)

High temperatures, in and of themselves, constitute another handicap. As given in mere statistics they cannot be appreciated; as actually experienced, they are difficult to describe without seeming to exaggerate. Fortunately, they do not prevail throughout the year, but during the warmer period they make of the valley a simmering oven. Daily summer maxima usually range from 105° F. to 110° F. in the shade; maxima of 110° F.

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[6] Brown, John S., *Routes to Desert Watering Places in the Salton Sea Region, California* (U. S. Geological Survey, Water-Supply Paper 490-A, Washington, 1920).

to 115° F. are common, and occasionally the extreme maxima reach 120°–125° F. The warmest month of the year averages about 94° F.; the warmer six months average about 85° F. (Fig. 5). The most trying times of all, usually in August, occur when moist air masses move in from the Gulf of California; then the combination of extremely high temperatures and high humidities has a nearly paralyzing effect, particularly on those who must be physically active.

High winds are further drawbacks. They are dry at all seasons, but during the warmer period they are especially searing in their effect. The strongest winds are those that pour through San Gorgonio Pass and down and across the full length of the Coachella.[7] On the valley floor they seize upon the dusts and sands of the Whitewater River drainway, or "wash" (Fig. 2; Pls. II, IV), to create a stifling and abrasive blizzard which scours desert brush, rocks, telephone poles, and even the paint of automobiles. One wonders what it must have been like to face such storms for hours at a stretch in the days of the wagon and stagecoach. The effects of violent winds are felt most from the San Gorgonio Pass to just south of Indio; from there to the Salton Sea they are still strong enough to carry tremendous loads of dust, but little sand is moved. If one is well up on the slopes of the bordering mountains during these severe "blows," the entire valley floor looks as though it were being inundated by a yellowish flood.

To the problems resulting from those atmospheric conditions already noted must be added others which are serious for short periods in some years. One of these is severe frosts. Mild frosts are the rule for about two months, but they do little or no damage to tree crops and cause only minor destruction of truck and field crops. That frost is not annually a serious problem is shown by the absence of heaters in the groves and fields. It is the occasional year of hard frost that witnesses great loss, not only of winter vegetables and field crops, but also of tree crops, such as dates, grapefruit, and oranges. January of this year (1949) saw record crop damage in the area.

Just as frosts may strike hard in some years and in certain districts, so do floods. Most of them occur along the valley margin, where "flash" waters from local mountain storms pour from deep canyons onto alluvial fans. Such floods affect only small portions of the agricultural section,

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[7] Mendenhall, Walter C., *Ground Waters of the Indio Region, California, with a Sketch of the Colorado Desert* (U. S. Geological Survey, Water-Supply Paper, 225, Washington, 1909), p. 9.

but they do wash out, or temporarily close, segments of highways and the railroad (Pl. III, Fig. 1). However, because of characteristic location on or very near alluvial fans, some of the resort settlements may suffer heavy damage. In rare years floodwaters enter the north end of the valley and sweep along the line of the Whitewater River drainway to the Salton Sea. When this happens, most roads and the railroad are affected, and sections of the agricultural area are endangered.

Other problems are associated with soils. Most of the extensive fan-piedmont soils (Fig. 3) are too coarse and bouldery for cultivation, except on the lowest fan margins. The portion of the more level area from San Gorgonio Pass to east of Palm Springs is a gravel-strewn wadi; a continuing portion extending to Indio is a large sand swell, shaped here and there into dunes of many types and sizes (Fig. 3; Pl. IV). The only section of the more level area which is largely free from sand and coarser materials is that extending from Indio to the Salton Sea.[8] But even here there are difficulties because of extensive alkali soils and numerous spots of salt marsh within the strong alkali area (Pl. III, Fig. 2).

To the physical handicaps of aridity, blisteringly hot summers, strong desiccating winds, dust and sand storms, occasional frosts and floods, and generally difficult soils are added others nonphysical in nature, such as lack of supply centers, undeveloped markets, and few and poor roads — not to mention competition from areas more favorably located and more richly endowed. The factors against settlement comprised an imposing total. That settlement occurred and has been maintained indicates that the white agriculturist was able to discover and utilize certain positive elements within the physical complex and, in so doing, managed to solve the economic problems.

The condition of extreme aridity was found to be in part ameliorated by geologic conditions. The floor of the valley is a very deep alluvial fill which collects and stores the meager waters from the mountains.[9] Also, the layers which comprise the fill are sufficiently varied and dipping to create an artesian basin in the region from Indio to the Salton Sea area (Fig. 3). In addition, there are a few spots where water is available in limited amounts outside the artesian section, chiefly on alluvial fans, along the thalweg upvalley from Indio, and at places where buried fault blocks force water near or to the surface.

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[8] Kocher, A. E., and Harper, W. G., *Soil Survey, The Coachella Valley Area, California* (U. S. Dept. of Agriculture, Bureau of Chemistry and Soils, No. 16, Series 1923, Washington, 1928).

[9] Mendenhall, *op. cit.*, pp. 10–28, and J. P. Buwalda, W. L. Stanton, "Geologic Events in the History of the Indio Hills and the Salton Basin, Southern California," *Science*, 71 (N. S.), No. 1830 (Jan., 1930): 104–106.

The presence of a large artesian supply was demonstrated in 1894, when the deep-drilled Southern Pacific well at Walters (now Mecca) was "brought in." Such drilling was very expensive, however, and many difficulties associated with deep drilling in loose materials were encountered. Few pioneer ranchers were in a financial position to pay the costs,

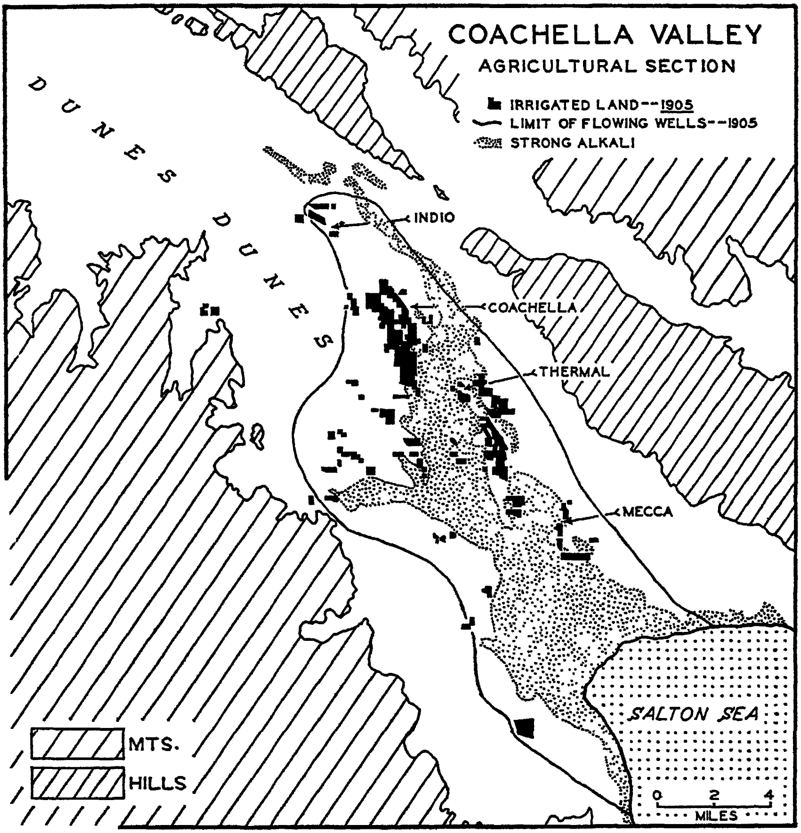

FIG. 6. The irrigated lands of the Coachella Valley in 1905. One may note their relationships to the region of strongly alkaline soils, to the flowing-well line (which is essentially the boundary of the artesian basin), and to the railroad (shown in Fig. 3), which extends through Indio, Coachella, Thermal, and Mecca. The influence of the range and township survey system is seen in the rectangularity of the cropped lands. (Map based on a map in Walter C. Mendenhall, *op. cit.*)

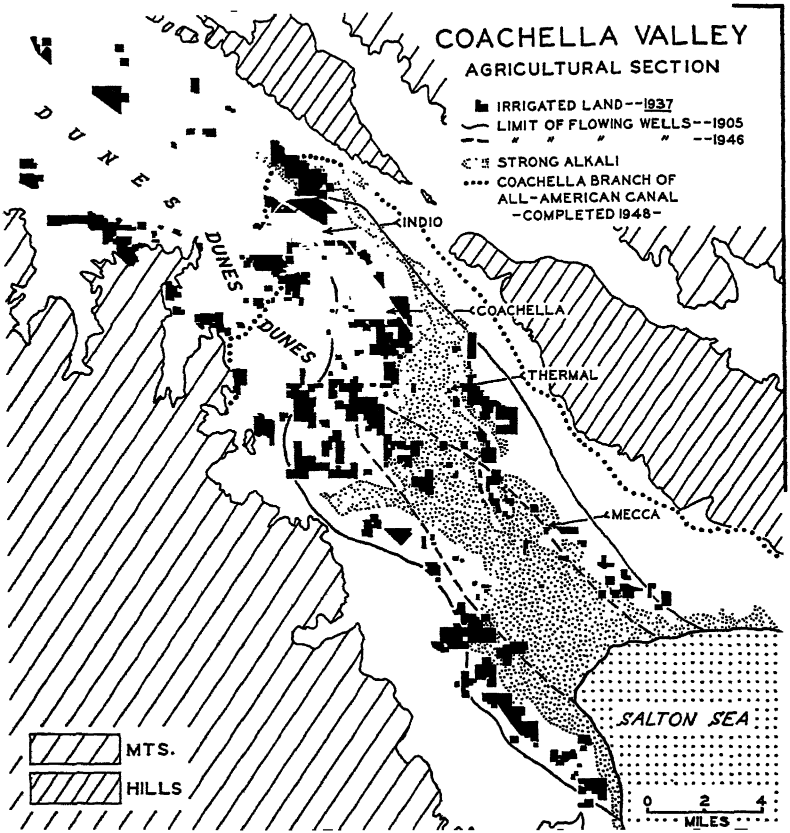

FIG. 7. The irrigated lands of the Coachella Valley in 1937. Since that date there has been a considerable increase in irrigated acreage, but no major change in the general pattern of cropped lands. The map shows the relationships of cropped land to the region of strong alkali, the artesian basin (marked by the limit of flowing wells in 1905), and the dune area near Indio. Note, also, the great shrinkage in the area of flowing wells and the fact that wells flowing at present are almost entirely in the strong alkali section. The position of the recently completed (1948) Coachella Branch of the All-American Canal is shown. Water from this canal will permit large increase in crop acreage, but only on lands which are down-slope from it (essentially the lands which lie below the sea-level contour, as shown in Fig. 2). (Map based on irrigated-land map in M. R. Huberty, and others, *op. cit.*)

and nearly all of them had to depend on scant supplies from shallow wells. In 1900 the situation changed almost overnight; a new type of well-drilling apparatus called the hydraulic well-drilling rig was introduced.[10] It was capable of drilling quickly and deeply into loose materials, and at comparatively low cost. Within seven years there were some 400 wells in the section from Indio to the Salton Sea, about 300 of which were at first flowing wells. Irrigated acres jumped from practically none in 1900 to between 4,000 and 5,000 in 1905[11] (Fig. 6). By 1923, 11,000 acres were under irrigation; by 1937, 16,000 acres (Fig. 7); and by 1948, about 22,000 acres.[12] During the same period the population of the agricultural area increased from a few score to about 15,000 persons.

At present there are about 700 major wells in the Coachella, mostly in the artesian portion, but flowing wells have nearly disappeared as the water table has lowered and as conflicts resulting from the pumping of many wells at the same time have occurred.[13] The past few years have witnessed some loss of crops because sufficient water was not available in certain places at critical times. Rough estimates, subject to considerable argument, seem to show that ground water is being removed about twice as fast as it is being replenished. Because of this and also to allow even greater expansion of cropped acreage, the Coachella Branch of the All-American Canal has been constructed (Fig. 7). In the desert the canal now constitutes a sort of man-made exotic stream to compensate for the lack of a natural one (Pl. V, Fig. 1). The canal itself was completed in 1948, but regular use of water from it awaits installation of an elaborate pipe-line system currently being laid. While the canal represents the greatest, and probably the ultimate, attack on aridity, it obviously played no part in the original settlement or in the succeeding expansion. In the future it will play a vital rôle in the continued maintenance of settlement and may result in as much as a 350 per cent increase in crop acreage.[14]

The high summer temperatures have been both utilized and combatted. High temperatures combined with irrigation have made the agricultural section a tropical greenhouse. The added factor of low humidity has allowed the production of dates to the extent that the Coachella is the "date capital" of the United States; it produces about 90 per cent of domestic dates and about 20 per cent of the total consumption[15] (Pl. V, Fig. 2). In 1948 Coachella dates had a market value of about $4.25 million. Winter and spring temperatures are sufficiently high to allow crop production to continue around the year and also make possible the capture of early markets for certain crops. In 1948, for example, early Thompson Seedless grapes sold for slightly more than $3 million. Thus temperatures which create problems also help to account for successful settlement. Man has made the heat more bearable by learning to use either simple or elaborate home air-conditioning systems and by constructing properly shaded and insulated buildings. Today many ranchers can afford to go to mountain cabins or to the coast to escape the hottest weather. Early ranchers tell of placing their beds outdoors and pouring water over the mattresses and of covering porches with burlap and soaking it down. So far as crops are concerned, frequent applications of irrigation water are necessary, especially in the hottest period. Dates receive about ten feet of water per annum (equivalent to 120 inches of rain), the bulk of which is applied in the warmer six months; alfalfa about seven; grapes, although growing chiefly during the comparatively cooler period, about four feet; and so on.[16] In the resort areas summer temperatures bring the recreation business to a virtual standstill.

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[10] Huberty, M. R., Pillsbury, A. F., Sokoloff, V. P., *Hydrologic Studies in Coachella Valley, California* (Agricultural Experiment Station, University of California, Berkeley, June, 1948), p. 5.

[11] Mendenhall, *op. cit.*, p. 40.

[12] Annual crop reports issued by the county agricultural agent, Riverside County, Riverside, California.

[13] Pillsbury, *op. cit.*, p. 45.

[14] Huberty and others, *op. cit.* See the entire reference for the water condition and use of water, present and future.

The high winds of the valley present a condition that is not easily met. In the resort areas people stay indoors or in the protection of patio walls when strong winds blow; in the agricultural section tree windbreaks partly protect homes and crops. Some truck crops are further protected by temporary low slanting walls made of sticks and heavy paper. These shelter from sandscour and decrease the searing effect, even though their primary purpose is protection against frost. However, open areas, including highways and streets, are dust-smothered and windswept without mercy, and some of them are temporarily covered by drifting sand.

So far there is little answer to the problem of the rare severe frosts. The same low slanting walls which offer some truck crops protection from winds help to minimize damage, but they do not protect taller crops, including those grown on trees. A few wind machines are used in some truck areas, but their efficacy at times of severe frosts is questionable. Because damage from frost tends to be "spotty," it would appear that microclimatic studies should be made to determine which crops should or should not be grown in specific areas.

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[15] Nixon, Roy W., *Date Culture in the United States* (U. S. Dept. of Agriculture, Circular No. 728, Washington, 1945).

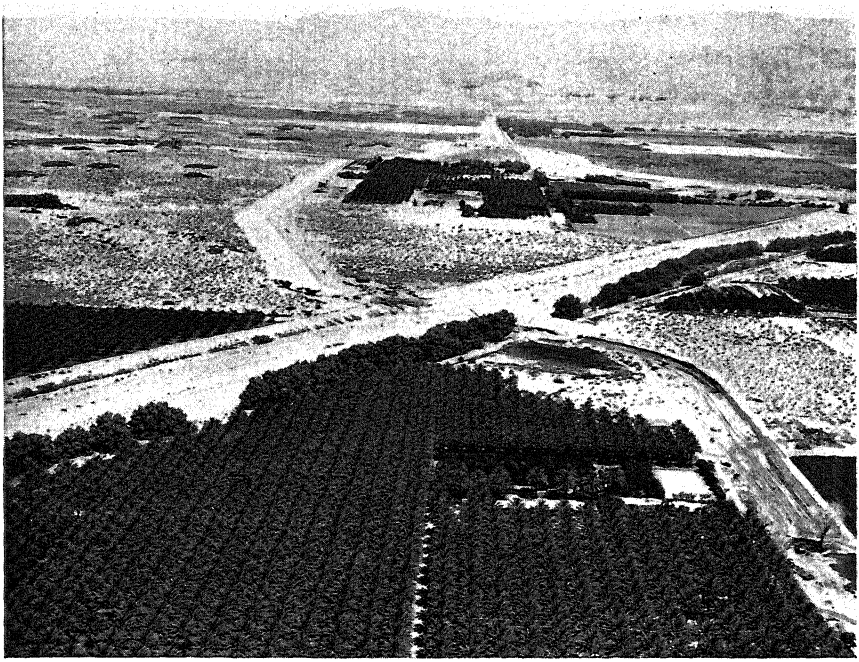
[16] Snyder, J. H. (Chief Engineer, Coachella Valley County Water District), "Irrigation Works Report: All-American Canal and Distribution System," Coachella, California, Feb., 1947. Unpublished.

The handicap of occasional floods has been only partly solved. Many resort areas and large sections of highway and railroad are protected by earthen dikes which divert the "flash" waters around the settlements or to highway and railroad underpasses. The main longitudinal drainway of the valley has been "storm-channeled" from just upvalley from Indio to the Salton Sea (Fig. 2; Pl. I). This protects the bulk of the cropped area and the agricultural towns. However, the rest of the main drainway upvalley from Indio is not controlled, and it would appear that a flood of major proportions would sweep down the valley and overwhelm the controls established in the agricultural section. Field evidence is clear that such floods have occurred many times in the past.

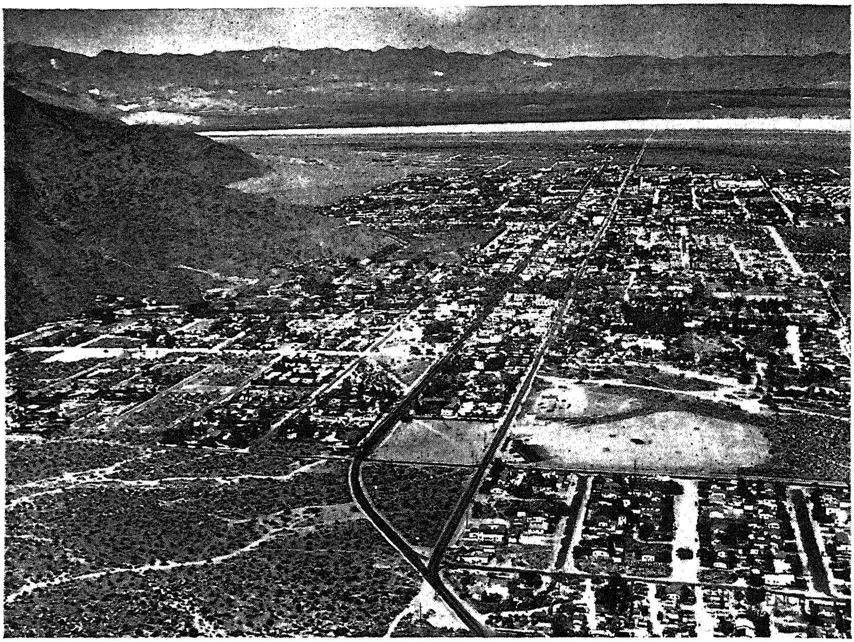
The problem of soils was met or partly solved in several ways. The fact that large amounts of irrigation water were available mainly in the artesian area ruled out any real attempts to utilize the generally sandy, gravelly, and bouldery soils of the extensive fan piedmont (Figs. 3, 6, 7). Furthermore, most of the flatter part of the valley northwest of Indio was patently too sandy or bouldery, even though some ground water was present along the thalweg (Pl. IV). There was left for cultivation mainly the part of the more level section extending from Indio to the Salton Sea. Agriculture first developed extensively in the area around and down the valley from the towns of Coachella and Thermal. But extensive areas were obviously too alkaline or too "seepy," and others, when put to use, proved to be of the same nature (Fig. 6). The result was abandonment of some ranches and the slow shift of the agricultural center of gravity in an upvalley direction. Today it centers around Indio and Coachella on the generally less alkaline soils (Fig. 7). It is interesting to note also that parts of the dune areas near Indio, areas completely sterile in outward appearance (Pl. VI, Fig. 1), have been leveled and put under irrigation. Land-use practices of this sort are recent and have been made possible by the huge leveling machines which accomplish in a few days what was not feasible by the use of horse and scraper and human muscle. It is a bit startling to see land composed of dunes and scattered creosote bush and mesquite bush transformed within a few weeks into level fields (Pl. VI, Fig. 2) clothed with green crops.

Thus the white settlers ferreted out and were capable of utilizing the favorable physical conditions and mitigating, enduring, or avoiding the unfavorable ones. By resourcefully meeting and continuing to combat the physical problems they were able to establish themselves on a difficult land (Pl. VII; Table I). As for the reasons why they attempted such an arduous task in the first place, there are many, and not wholly satisfactory, answers. Some hoped to develop the land and sell at a profit. Others felt that certain fruits and vegetables, including early ones, could be marketed profitably in the growing Los Angeles region and, perhaps, in Eastern cities, and some thought that specialized date production was the road to quick riches. Still others believed that they could establish for themselves an essentially self-sufficient economy in an area where food for man and animals could be grown the year around. Furthermore, the Coachella, unlike many deserts, has excellent drinking water — an important consideration to many persons, particularly during the long hot season. And, queer as it may sound, a few merely liked to live in a desert, and they found the Coachella an unusually interesting one. Whatever the exact reasons, the Coachella was settled and, fortunately, local and extralocal market demands, plus improvements in transport and handling methods, enabled the original settlement to endure and expand, and now the use of plentiful canal water promises even greater expansion.

University of California
Los Angeles, California



Looking north to the Indio Hills and the Little San Bernardino Mountains from a point west of Indio. The contrast between raw desert land and irrigated land is evident. This is part of the area which has been reclaimed by the leveling of large and small dunes, the larger of which (not leveled) appear to the left, beyond the crop land, as dark patches crowned with mesquite. The light strip extending obliquely from left to right is a section of the Whitewater River drainway that has been placed under "storm control"; the light strip which angles across the drainway is the Coachella Canal under construction. A large date grove is in the foreground. (Photograph by Hartman Studio, Indio, California, 1947)



Looking north across Palm Springs, the largest of several winter resorts that mark the northwestern part of the Coachella Valley. The white band in the background is the most recent location of the Whitewater River "wash" as it streams out of the entrance to San Gorgonio Pass (to the left). (Photograph by Spence Air Photos, Los Angeles, California, 1946)

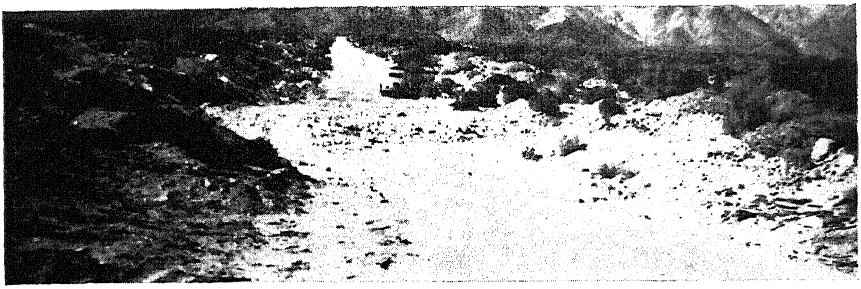


FIG. 1. Section of "alluvial fan road" blocked by debris from a recent torrential rain in the adjacent mountains

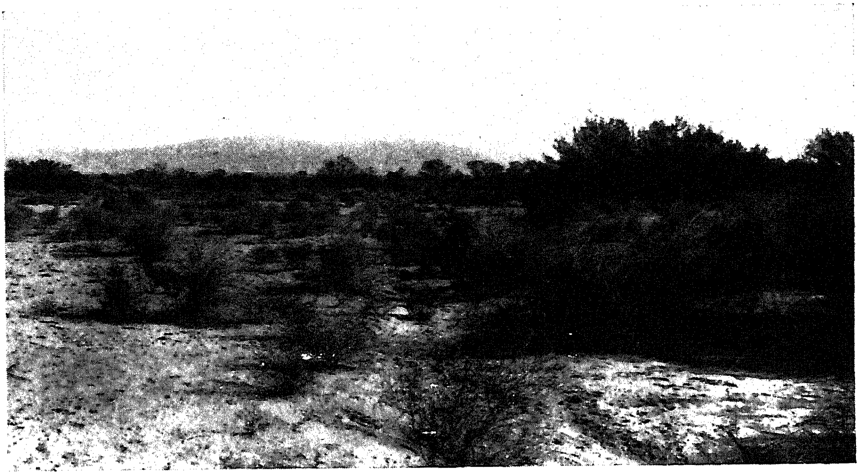
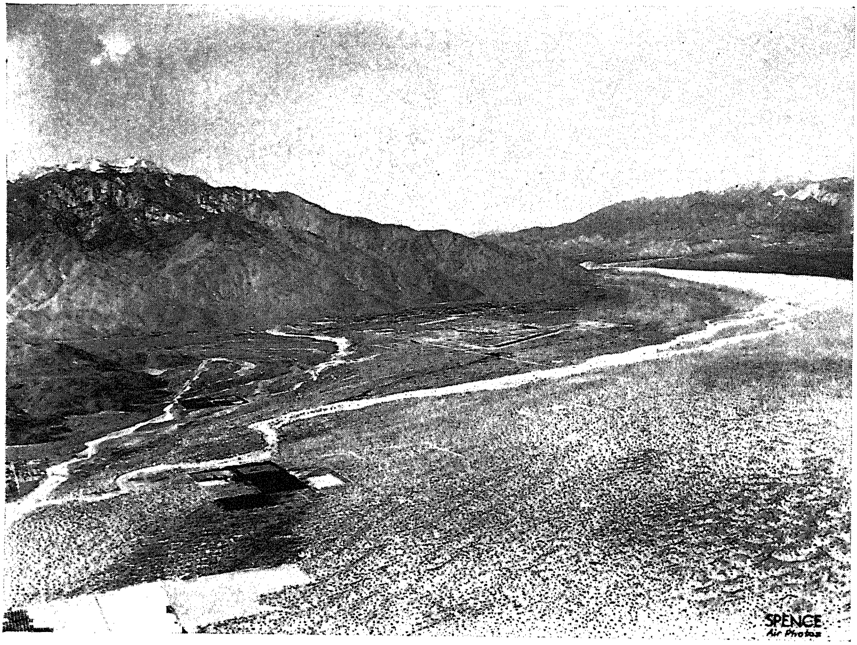


FIG. 2. Part of the strongly alkaline area southwest of Mecca; it is sprinkled with tall mesquite and several species of low xerophytic shrubs



A view upvalley (from a point west of Indio) across the area of major sand accumulation and on to Mt. San Jacinto in the left background. The drainway of the decidedly intermittent Whitewater River appears clearly as it issues from San Gorgonio Pass and curves down the valley floor. Palm Springs is in the center of the photograph. The black rectangles are isolated date-grapefruit ranches. To their left is a small part of the resort town of Cathedral Springs. (Photograph by Spence Air Photos, Los Angeles, 1946)

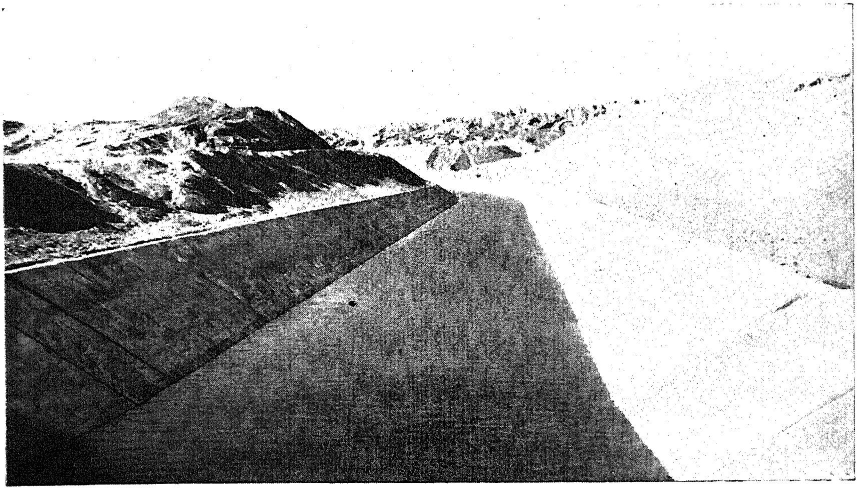


FIG. 1. Section of the Coachella Branch of the All-American Canal where it intersects part of the lowest margin of the Mecca Hills

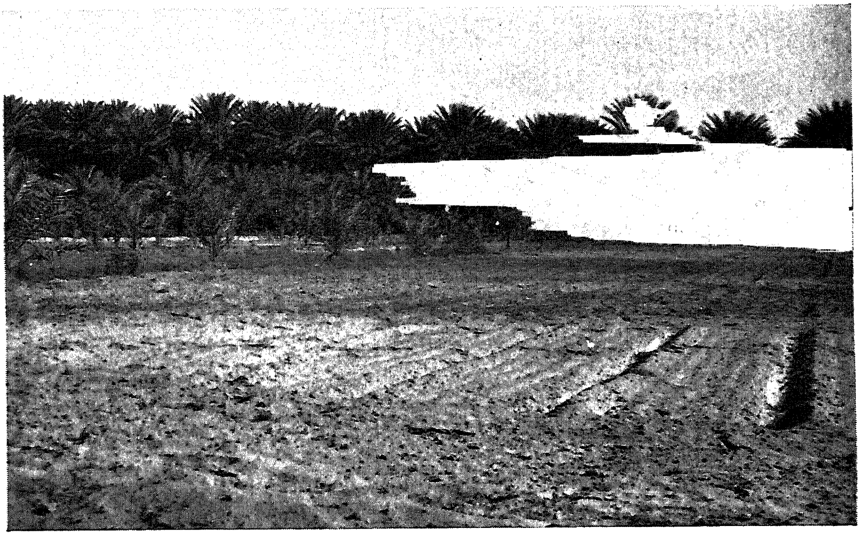


FIG. 2. Date groves near Indio; old palms in background, young palms in part of foreground

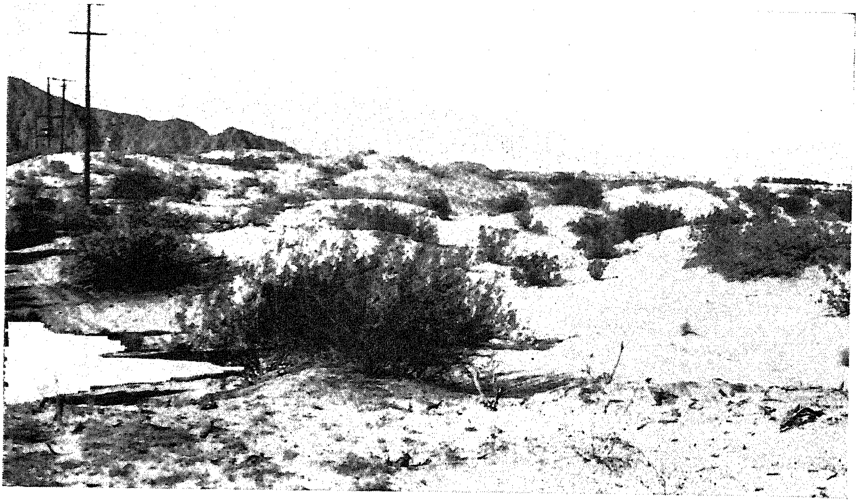


FIG. 1. Characteristic appearance of the dunes in the sand accumulation area near Indio. The vegetation is creosote bush

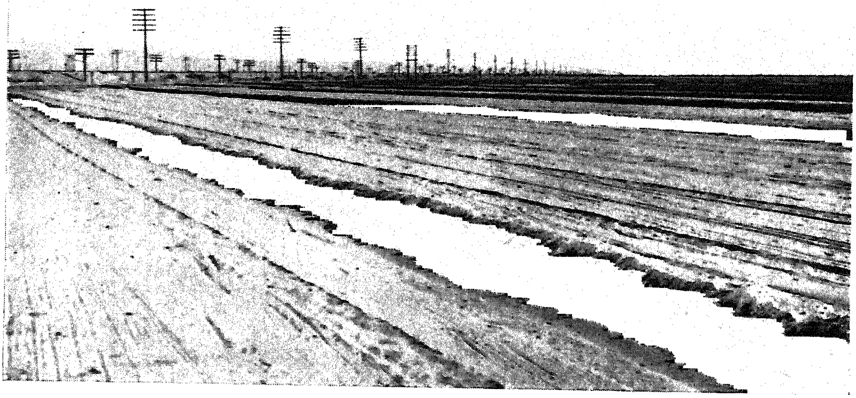
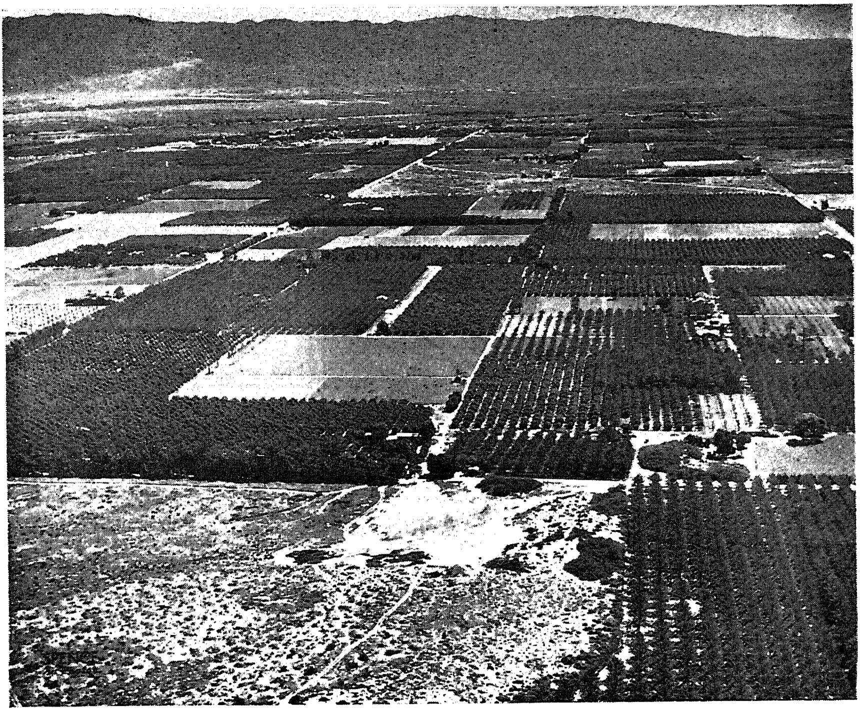


FIG. 2. Dune land just leveled and ready for irrigation, along the railroad near to and northwest of Indio. Two weeks before this photograph was taken the land had essentially the appearance shown in the figure above; two months later it was covered with a good stand of alfalfa



Part of the agricultural section of the Coachella Valley, looking east. There is a marked contrast between the raw land and the cropped land in the foreground. Dominant crops appear in different "textures": dates, right foreground; grapefruit, left foreground; truck crops, "smooth" fields; grapes, widely spaced rows in center at right. (Photograph by Spence Air Photos, Los Angeles, 1941)

THE FUTURE OF IRON MINING ON THE MARQUETTE RANGE, MARQUETTE COUNTY, MICHIGAN

ROBERT J. GOODMAN

HOW long will the iron ore last?" is one of the questions paramount in the minds of residents on the Marquette Range (Fig. 1). A satisfactory answer to this query involves the consideration of variable factors: (1) cost of production; (2) cost of marketing; (3) iron content of the ore; (4) actual and potential reserves; and (5) variation of market demands.

Recent costs of production of iron ore have reduced the profit in mining (Fig. 2). As a result of increasing wages and a disproportionate increase in retail price, the theoretical profit on ore dropped from ninety cents per ton in 1939 to three tenths of a cent in 1944.[1] Such a drop is not conducive to sustained maximum production. Profits are high in prosperous years if wages and other prices are near average (1937), but profits are low in years of recession (1938) and in periods of inflation. This decrease in profit discourages a mining company from risking capital in the discovery and development of new reserves. As a consequence, these conditions tend to conserve the amounts of ore available.

Ore taken from the underground mines of the Marquette Range must compete with the open-pit ore of the Minnesota ranges (Table I). The latter is cheaper to mine, but position with respect to market, land ownership, state taxes, and marketing techniques allow the mines of the Marquette Range to operate at a profit within the margin of difference.

The Marquette Range has an advantage over the ranges of Minnesota and Wisconsin in position with respect to market. Not only is it closer to the nation's ore markets than the other ranges, but the mines in it are the closest to ore-shipping ports. These positional advantages explain why the lower rates of transportation of ore are in effect for the ports of Marquette and Escanaba (Table II). It may be noted that the all-rail rates from the Upper Lakes to Granite City, Illinois, is $2.50 per gross ton.

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[1] Wolff, J. F., "The Economics of Underground Mining," *Skilling's Mining Review,* 34, No. 51 (1946): 14.

The mines on the Marquette Range are for the most part on lands owned by the companies which operate them. This ownership enables the operators to save royalties of forty cents to a dollar on each ton of ore. State taxes on the production of underground ore are consistently lower in Michigan than in Minnesota (Fig. 3). This difference in favor of Michigan has been as high as twenty-three cents per ton,[2] and the tax policy of Michigan acts as a conservation measure. Michigan allows a period of ten years to elapse after the discovery of ore before the new

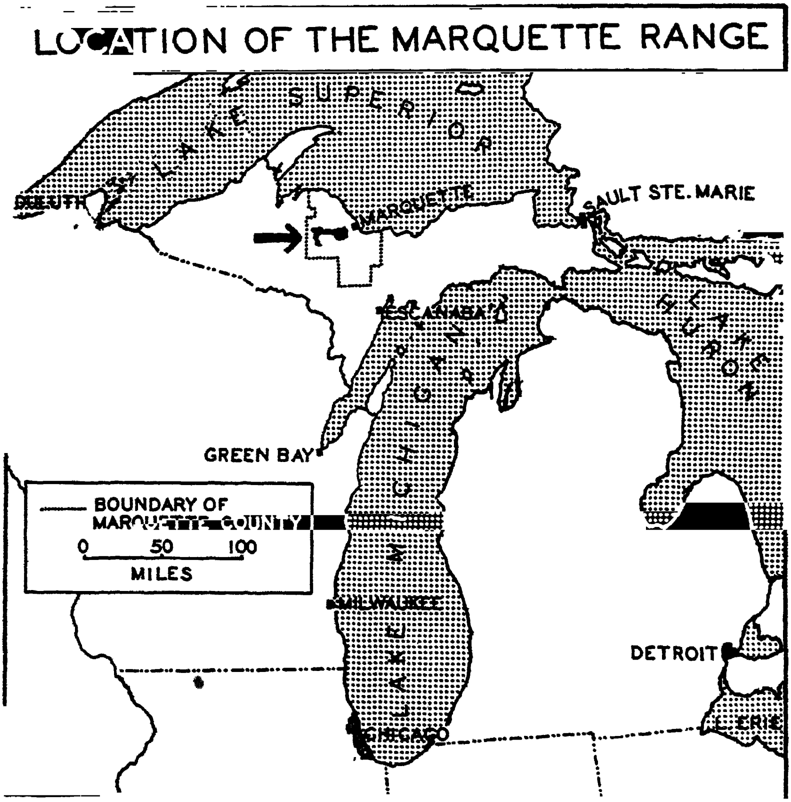

FIGURE 1

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[2] *Ibid.*, p. 14.

reserve is subject to full taxation. This policy encourages exploration for, and rapid development of, new reserves. Minnesota, in contrast, taxes such reserves of ore soon after discovery.

TABLE I

Crude Iron Ore Mined in the United States, 1945*

Area of production	Method of production		Total production
	Open pit	Underground	
All of United States	78,935,218†	27,377,181	106,312,399
Michigan	564,278	11,301,346	11,865,624
Minnesota	68,022,925	4,194,928	72,217,853

* Source: *Skilling's Mining Review,* 35, No. 29 (1946): 1.
† All figures are given in gross tons.

TABLE II

Rail and Lake Freight Rates on Iron Ore*

Port	Rate per gross ton		
	By rail from Range to port†	By Lake from port to Lower Lakes‡	Total cost
Marquette	$0.685	$0.955	$1.64
Escanaba	0.925	0.685§ 0.820‖	1.61§ 1.74‖
Ashland	0.925	1.045	1.97
Minnesota ports and Superior, Wis.	0.955	1.045	2.00

* Source: *Skilling's Mining Review,* 35, No. 20 (1945): 11.
† Includes dock-handling charge, $0.115 per ton.
‡ Includes unloading charge, $0.145 per ton.
§ Lower Lake Michigan. ‖ Lake Erie.

In marketing techniques the Cleveland-Cliffs Iron Company, largest operator on the Marquette Range, has its own railroad,[3] ore boats, and by-products plants. These measures effectively reduce the cost of ore from the Marquette Range at the lower lake ports and tend to hasten exploitation of the ore reserves.

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[3] Lake Superior and Ishpeming Railroad, built in 1896.

The iron ore of the Marquette Range has a high ferric content. Ore must have an iron content of at least 57 per cent to be mined economically for the present-day market. If the content falls below this figure, the companies cannot market the ore at a profit. Fortunately the ore of the Marquette Range of the spicular hematite and magnetite varieties assays well over 60 per cent, and some of it is mixed with poorer grades of ore to improve the latter's content.

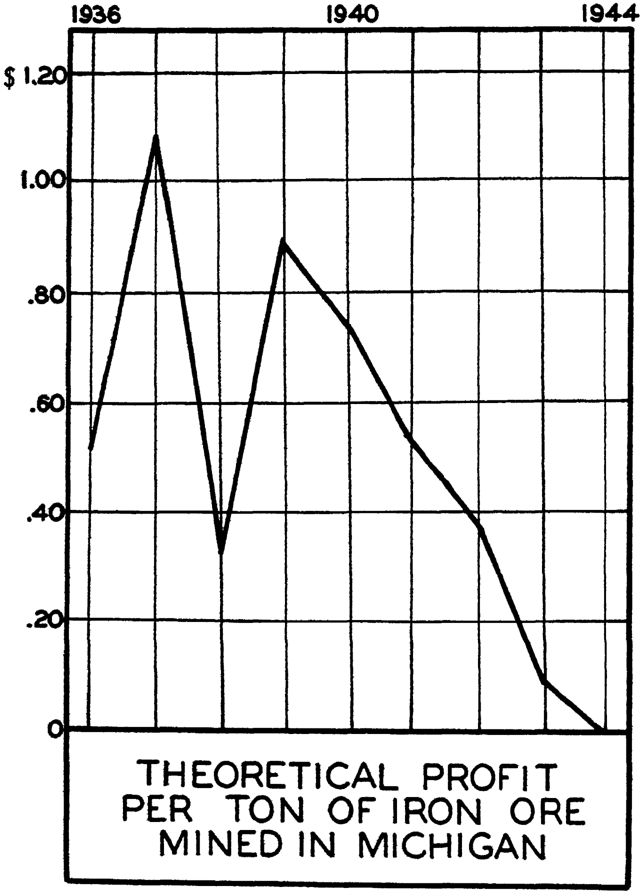

FIGURE 2

Large reserves of potential[4] and actual[5] iron ore exist on the Marquette Range, but at the present rate of consumption the proved reserves will be exhausted in twenty years if new discoveries are not made. The rate of depletion of reserves on the Mesabi Range was accentuated noticeably during the recent war years (Fig. 4), whereas during the same period estimated reserves on the Marquette Range increased slightly.

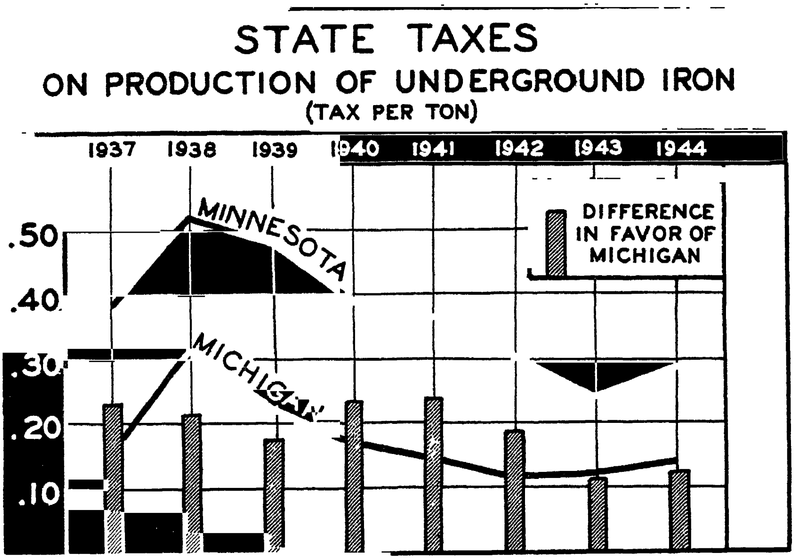

FIGURE 3

An estimated world reserve of 35.2 billion tons of actual ore and 164.8 billion tons of potential ore[6] in 1944 indicates that potential ore will become increasingly more important in the future. The Marquette Range, which has mined only rich ore, in the future must draw heavily on ores with lower iron content. Potential ore can undergo "beneficiation"[7] before shipment. Research is being conducted with a view to improving it, and "the next few years promise steady advances in the beneficiation of iron ores."[8] The supply of exploitable ore depends, in large measure, upon the progress which is made in beneficiation.[9]

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[4] Ore which the mining companies are unable to utilize today in competition with ores now supplying the market. Potential ore can be too low in iron content, too high in undesirable constituents, or inaccessible to steel plants or markets by reason of distance. White, C. M., *Iron Ore and the Steel Industry* (New York: Republic Steel Corporation, 1947), p. 12.

[5] Ore which is mined and fed into the furnace of the world today; ores from which steel is now being made in plants operating in successful competition with one another. *Ibid.*, p. 13.

[6] *Ibid.*

[7] A term used in mining to embrace all types of concentration of low-content ores.

Market demands directly affect the production of iron ore on the Marquette Range, and therefore enter into calculations bearing on the life expectancy of ore reserves. In years of national prosperity, when the demand for steel is high, the mines of the Marquette Range produce enormous amounts of ore. Conversely, in periods of national depression relatively small tonnage is produced. It has been estimated that we in the United States are today (1947) using 1,250,000,000 tons of iron and steel to operate our present economy.[10] We are adding to that figure 65,800,000 net tons of steel annually, and would have produced 80,000,-

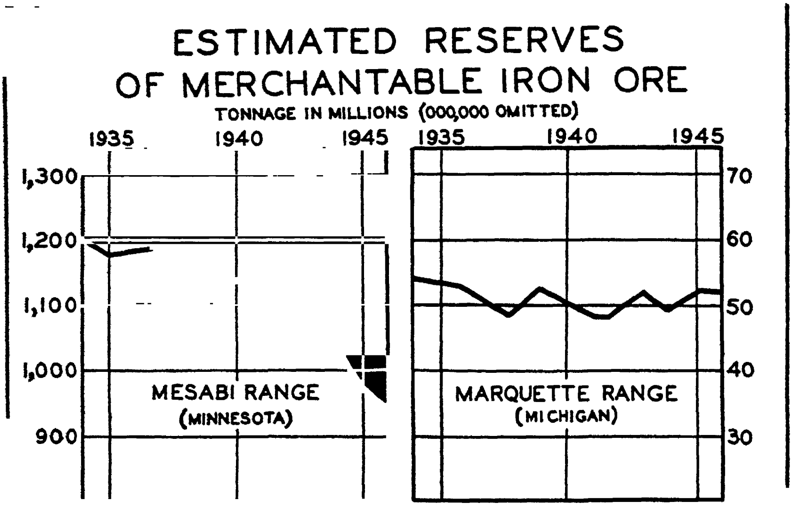

FIGURE 4

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[8] Maxson, Walter L., "Quality and Characteristics of Future Iron Ore Supply," *Skilling's Mining Review,* 35, No. 6 (1946): 4.

[9] For a discussion of beneficiation and its relationship to reserves on the Marquette range see George H. Primmer, "Future of Lake Superior Iron Ore Supply," *Economic Geography,* 10 (1934): 397–398.

[10] White, *op. cit.,* p. 27.

000 tons in 1946, had it not been for strikes.[11] This present great demand hastens the depletion of the known reserves.

Thirteen mines are active on the Marquette Range (Fig. 5). This number represents a consolidation of operations, for although total production figures remain relatively constant, each decade sees the closing of several mines. One new shaft is being sunk to tap extensive proved reserves. Such consolidation effects advantages in marketing ore, and indirectly acts as a conservation measure.

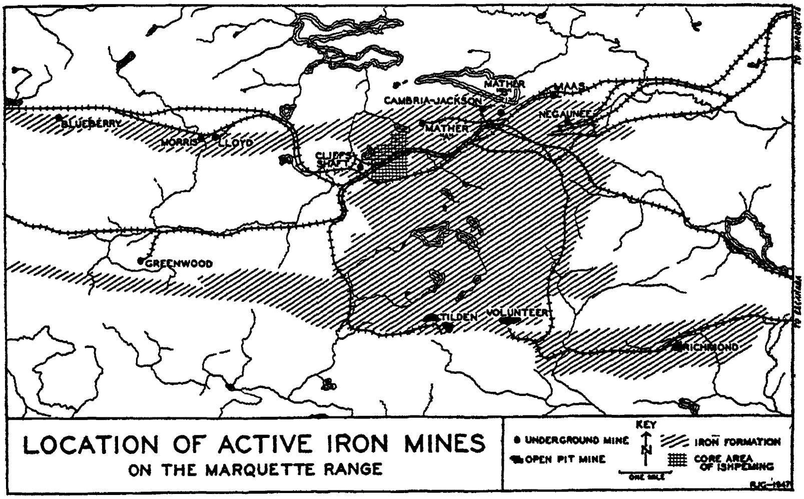

FIGURE 5

Demand for iron ore is variable. Primmer suggested that substitutes and the use of scrap tend to decrease demand, and thereby "substitutions and re-use patently tend to prolong producing life of the ore areas."[12] Perhaps development of the Brazilian or Cuban reserves will materially affect the demand for the ore of the Marquette Range. If the mines continue to yield ore of high iron content, however, and if other conditions continue generally as they are, the Marquette Range will be in a relatively safe production position for at least fifty years.

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[11] Tower, Walter S., "Steel Production," *Skilling's Mining Review,* 35, No. 27 (1946): 1.

[12] Primmer, *op. cit.,* p. 400.

THE ZUIDER ZEE RECLAMATION PROJECT*

GEORGE W. HOFFMAN

A FRENCHMAN once said: "God created the world except the Low Countries, which were created by the Dutch." Maps made throughout the centuries show the changes in the land area of the Netherlands. In the early Middle Ages water broke through the outer island chain of North Holland and Friesland and formed an area of swamps which was named "Flevomeer" by the few persons who inhabited this region. This is the area which later became known as Zuider Zee.

Not until the end of the Middle Ages did the Netherlanders begin the struggle against the sea and take the offensive in protecting their property from its encroachments (Fig. 1). The struggle for land was most intense in the province of North Holland, where the coastline in 1300 was nearly 3,000 feet farther to the west than it is now. The numerous lakes of this area were joined together, but with each storm more land disappeared until islands dotted the landscape of the province in 1500. "Take my spade, take my land" was characteristic of the early Netherlander's fight for his soil. "Anyone who took up the spade became owner of the land" and was responsible for the upkeep of the dike, since each man's property was protected by dikes, for the most part without regard for his neighbor's property. If his work or the cost of maintaining the dike was too great, "he put his spade vertically into the ground."

With increasing floods due to rising river bottoms and deforestation, the construction and maintenance of dams and dikes became a commu-

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*I visited Holland and the Zuider Zee area briefly in 1938 and again during the summer of 1948. This report is based on my own observations, many interviews, and discussions with inhabitants of the Wieringermeer polder, Dutch government officials, members of the Netherlands Association for Land Reclamation, and my close friend Mr. L. Tas, marine engineer at Amsterdam. Appreciation is extended to the Netherlands Information Bureau in New York, especially to Mr. M. M. Lourens of its Research Division and to Mr. F. J. B. G. Geers of the Dienst van de Zuiderzeewerken, The Hague, for furnishing additional information and the latest statistics.

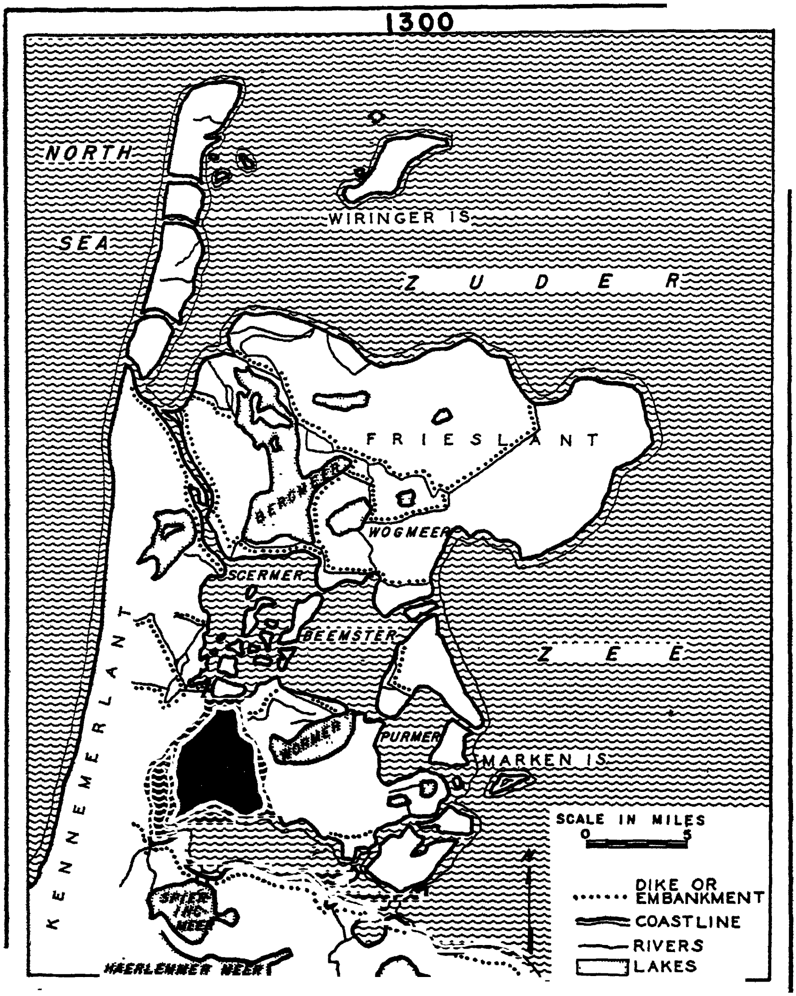

FIG. 1. North Holland (modified from Dienst van de Zuiderzeewerken)

nity project.[1] While the building of dams as a defensive measure had been practiced for some time, the adaptation of windmills to pumping

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[1] Netherlands Information Bureau, *Netherlands News Letter,* Aug. 1, 1947, II (4): 8.

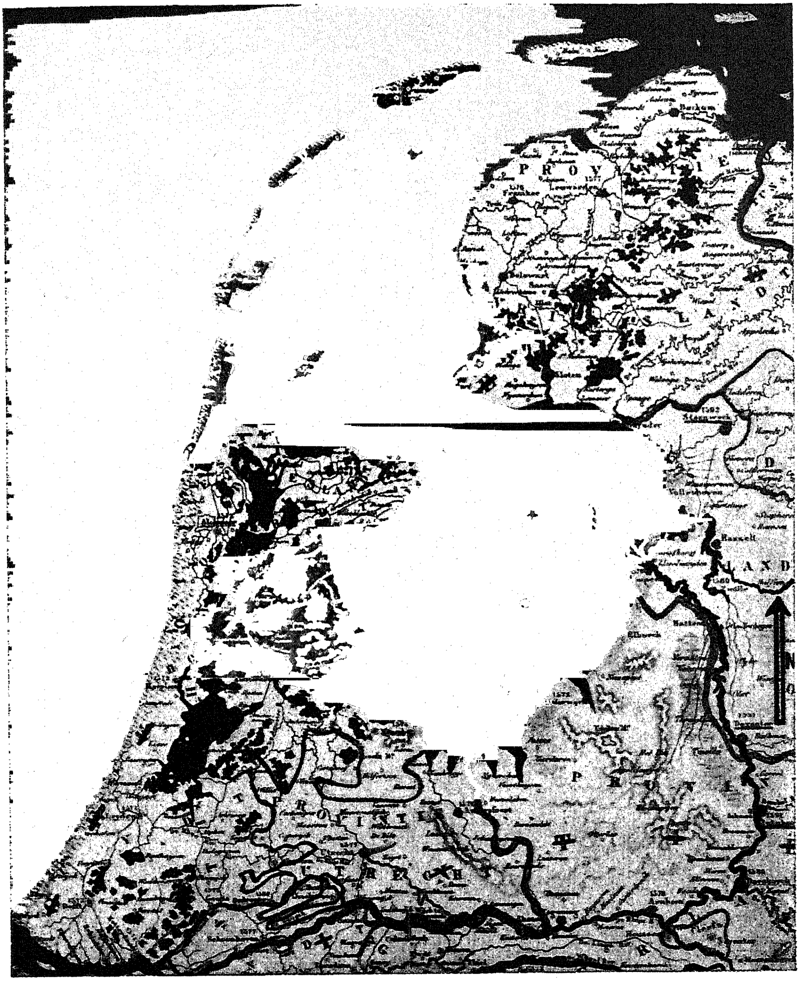

FIG. 2. Northern and western sections of the Netherlands in the sixteenth century (*Netherlands News Letter,* Vol. II, No. 4 (August, 1947)

in the early 1400's encouraged the draining of small lakes[2] (Fig. 2). Beemster Lake, with an area of about 18,000 acres, was drained by Am-

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[2] The water mill was first used in 1408. "The name of the inventor has remained unknown. In 1947, 583 of these mills, each with a capacity of 50 H.P. or more and carrying 90 cubic yards of water a minute, were still in use according to the Netherlands Information Bureau." *Ibid.,* p. 8.

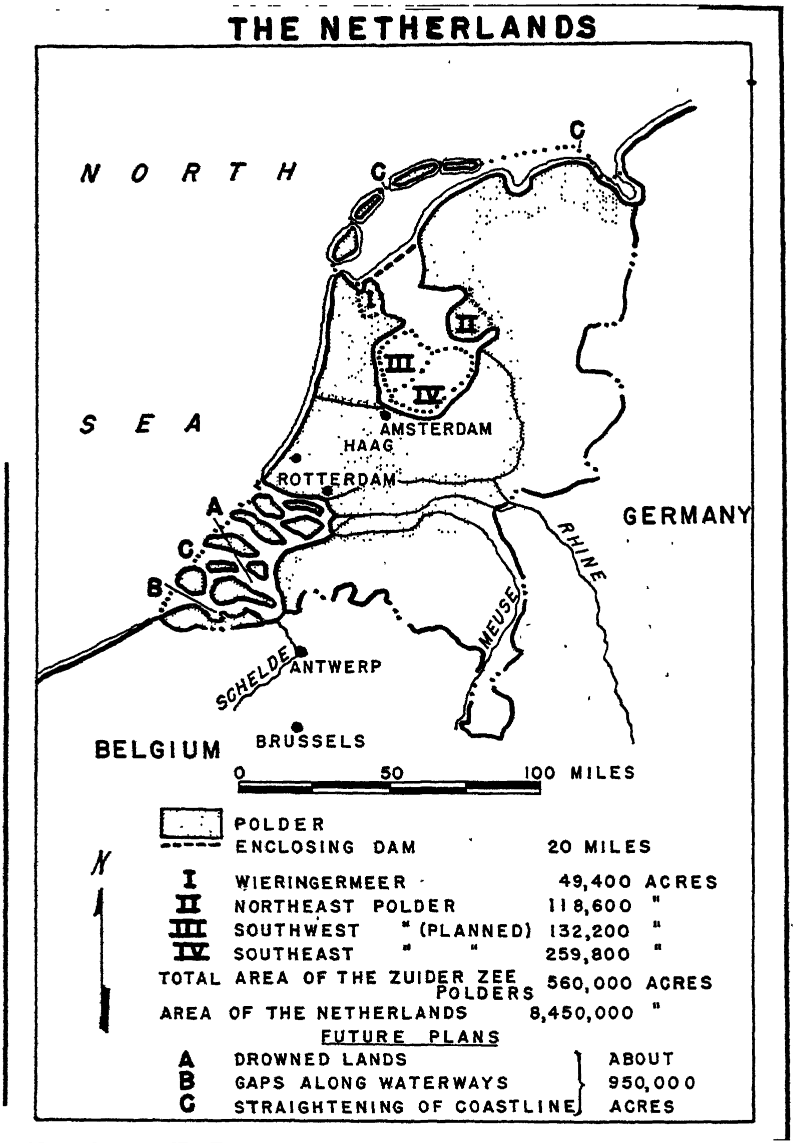
THE NETHERLANDS
NORTH SEA
C
C
I
II
III
IV
AMSTERDAM
HAAG
ROTTERDAM
A
C
B
GERMANY
RHINE
MEUSE
SCHELDE
ANTWERP
BELGIUM
BRUSSELS
0 50 100 MILES
POLDER
ENCLOSING DAM 20 MILES
N
I WIERINGERMEER 49,400 ACRES
II NORTHEAST POLDER 118,600 "
III SOUTHWEST " (PLANNED) 132,200 "
IV SOUTHEAST " " 259,800 "
TOTAL AREA OF THE ZUIDER ZEE POLDERS 560,000 ACRES
AREA OF THE NETHERLANDS 8,450,000 "
FUTURE PLANS
A DROWNED LANDS
B GAPS ALONG WATERWAYS
C STRAIGHTENING OF COASTLINE
ABOUT 950,000 ACRES

Figure 3

sterdam merchants as a commercial venture in 1612. During the next forty years three other lakes,[3] with a total of 23,000 acres, were drained, and the land thus reclaimed produced vegetables and fruits for the Amsterdam market. Until 1919, when the Zuider Zee project was started, the most difficult and biggest project of Dutch land reclamation was the drainage, in 1856, of the 46,000-acre Haarlemmermeer, located between The Hague and Amsterdam. Lands thus reclaimed are known as polders.

The 300 to 400 lakes of various sizes in North Holland that were drained in the last five centuries are guarded by approximately 1,800 miles of dikes; they have contributed more than half a million acres to Holland's fertile land. "If these dikes should collapse, cities [such] as Amsterdam, Rotterdam, and many others would be buried under the sea. The catastrophe that befell Walcheren Island due to Allied air raids during the last war months, and the wilful flooding of Wieringermeer Polder and other areas by the Germans laid waste 17 per cent of Holland's 5 million acres of agricultural land."[4]

Five and one-half million people, or approximately 45 per cent of the total population of the Netherlands, live below the average level of the sea (Fig. 3). A complicated system of windmills, steam and diesel pumps, ditches, canals, and dikes controls the flow and level of the water of the polder lands.

It is the purpose of this paper to discuss some of the construction features and settlement problems of the Zuider Zee project and to point out several of the rehabilitation problems arising from the last war.

PREPARATORY WORK

With the completion of the drainage of the Haarlemmermeer, the reclamation of the vast Zuider Zee area became a practical possibility. Scientific studies of the sea bottom in 1800 showed areas of fertile clay and loam as well as of less fertile sand.[5] These studies helped the polder making. Soil was tested to a depth of five feet. Microbiological tests were used to determine what the future cultivation should be. The sea bottom of the Zuider Zee and the area adjacent were measured and found to be at a depth of about ten to fifteen feet. In 1896 a government commission approved the diking and draining of the Zuider Zee. Large-scale inundations and a shortage of wheat induced the Dutch Parliament at the end of the First World War to adopt a bill providing for the complete drainage of the Zuider Zee.

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[3] Purmer (6,750 acres), Wormer (4,000 acres), and Schermer (12,075 acres) were drained before 1650.

[4] *Netherlands News Letter* (as cited in note 1), p. 7.

[5] Canals in the polder were dredged while the dike was being constructed. The fertile clay thus extracted was dumped on the sandy patches.

DIKING AND DRAINING

There were two phases of the Zuider Zee project. The first was to cut this sea off from the North Sea by two dams. One of them is about one and one-half miles long and connects Wieringen Island with the north coast of North Holland by way of Amsteldiep. The other, the enclosing dam (Afsluitdijk), which is about twenty miles long, connects the island with the coast of Friesland Province near the village of Zurig, south of Harlingen. The second phase is the diking and draining of four polders (Wieringermeer, Urkerland, or Northeast, Southeast, and Southwest polders) in order to make of the Zuider Zee a fresh-water lake, called Ijselmeer (Ijsel Lake).

Work on the project was started in 1919. Owing to unforeseen reverses it took over four years to build the smaller dike across Amsteldiep, which ranges in width from ten to forty feet. The large enclosing dam was begun in 1926 in three different places. This difficult undertaking was completed in May, 1932, and the Zuider Zee became Ijsel Lake. It serves as a basin for the Ijsel River, which discharges one ninth of the water from the Rhine. Various smaller rivers flow into the lake, which also receives the water pumped from the reclaimed land.

THE ENCLOSING DAM

The two enclosing dams are twenty-five feet above mean sea level. The twenty-mile dam is 300 feet wide and has a 100-foot highway, with ample space left for a double-track railroad, to be built in the future, and several paths for pedestrians and cyclists. The dam connects the Dutch provinces of North Holland and Friesland, and shortens the route from Amsterdam to Friesland by more than half. Its twenty-five sluices permit the discharge of surplus water from Ijsel Lake. A protective sill dam, made of a brushwood mattress and filled with heavy stones, was constructed in front of the sluices. This sill dam guards against the scouring of the sea bottom by water passing through the sluices.

In the construction of the dam, boulder clay was discharged from hoppers or plain barges by means of floating cranes to raise the sea bottom. "Heavy loam, of glacial origin, formed the basis of the main dam." After this operation, sand was dumped. "On the inner side, the dam was then faced with boulder clay, and finally both sides were covered with basalt boulders above and brushwood mattresses below the water-line, thus affording a completely adequate protection against storm tides."[6] The most difficult part of the construction was the closing of the gap between the sides. With the decreasing open space, a corresponding increase in the velocity of the tidal flow had to be reckoned with. The tidal changes and the effects of the flow of water against the dikes had been calculated from the results of the experiments in the hydraulic laboratory.

DIKING AND DRAINING OF WIERINGERMEER POLDER

An experimental polder of about one hundred acres was completed at Andijk during the construction of the enclosing dam. On it experiments were carried out to discover the best method of extracting the salt to make cultivation possible. The tests were satisfactory, and the land produced a good crop of grasses and clover in the year after it was drained. Experimental plots on each new polder were used to test the effects of various types of fertilizers and manures.

In 1926, while the great dam was being built, the diking and draining of the first polder of the Zuider Zee was begun. The dike for it, the Wieringermeer polder, was completed by 1929, and water was piped across the dike the next year. By the summer of 1930 the 49,500 acres of the new polder were dry.

Two electrically driven pumping stations completed the work of draining the Wieringermeer polder in six and one-half months. The Lely pumping station near Medemblik has "three centrifugal pumps with vertical shafts of a total capacity of nearly 260,000 gallons per minute"; the Leemans station, at the northeastern corner of the new polder, near Den Oever, has "two six-cylinder diesel engines driving the two centrifugal pumps and giving them a capacity of more than 120,000 gallons a minute."[7] Transformation of the heavy salt-laden land into agricultural soil was achieved by lowering the water table of the polder four to five feet below the lowest ground level, and soil was reclaimed during the spring of 1931.

Intensive draining is of the greatest importance in the cultivation of new land in order to secure gradually increasing permeability as well as to eliminate salt rapidly. It is accomplished by a system of canals, ditches, trenches, and tiling in each polder. Before the actual work of reclamation is begun, canals are made by dredgers (Pl. I, Fig. 1). After the water is pumped out of the polder the principal ditches connecting the canals are dug. They are drawn with mathematical straightness by a special mechanical digger, and are called draglines. Their length is determined by the size of the holdings; the average length is 2,400 feet, the distance between them, 800 feet; and their depth, about 4 feet 8 inches. After the ditches have been dug, the digging of small trenches follows. They are two feet deep, and their length ranges from twenty to sixty feet, depending on the kind of ground.

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[6] *Fresh Fields and Polders New, The Story of the Zuiderzee Works,* Association "The Netherlands Abroad" (1947), pp. 11–12.

[7] *Ibid.,* pp. 20–22.

The next phase is tiling, which is not possible until the land has been under cultivation for a few years. Transportation of tiles on the muddy new ground would be impossible and, moreover, tiles would sag during the first drainage process, when the soil is subsiding. There is the additional consideration that it is better to discharge the water on new land by means of open trenches than by tiling. The distance between tiles may be greater than that between trenches because soil becomes better and more permeable to water during the first years of cultivation. The tiles, the laying of which begins at the middle of the field at an average depth of three feet three inches (two feet deep at the middle of each parcel and four feet at the connection with the small ditches), have greater effect than the trenches.[8]

CULTIVATION OF THE WIERINGERMEER POLDER

Shortly after the draining of the Wieringermeer polder, rye was planted. At first only shallow tillage was possible, but soon thereafter farms were laid out all over the polder, and three modern farming villages (Slootdorp, Middenmeer, and Wieringerwerf) were built (Pl. I, Fig. 2). A network of canals and modern bridges makes transportation easy and permits direct barge transportation from these villages to Ijsel Lake and Amsterdam. These main canals are nine feet deep and twenty-six feet wide. The two major pumping stations are located on them.

The total area of the Wieringermeer polder is 49,500 acres, approximately 9 per cent of the total reclamation project of the Zuider Zee. Of

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[8] Information received from farmers and a detailed report from the Dienst van de Zuiderzeewerken.

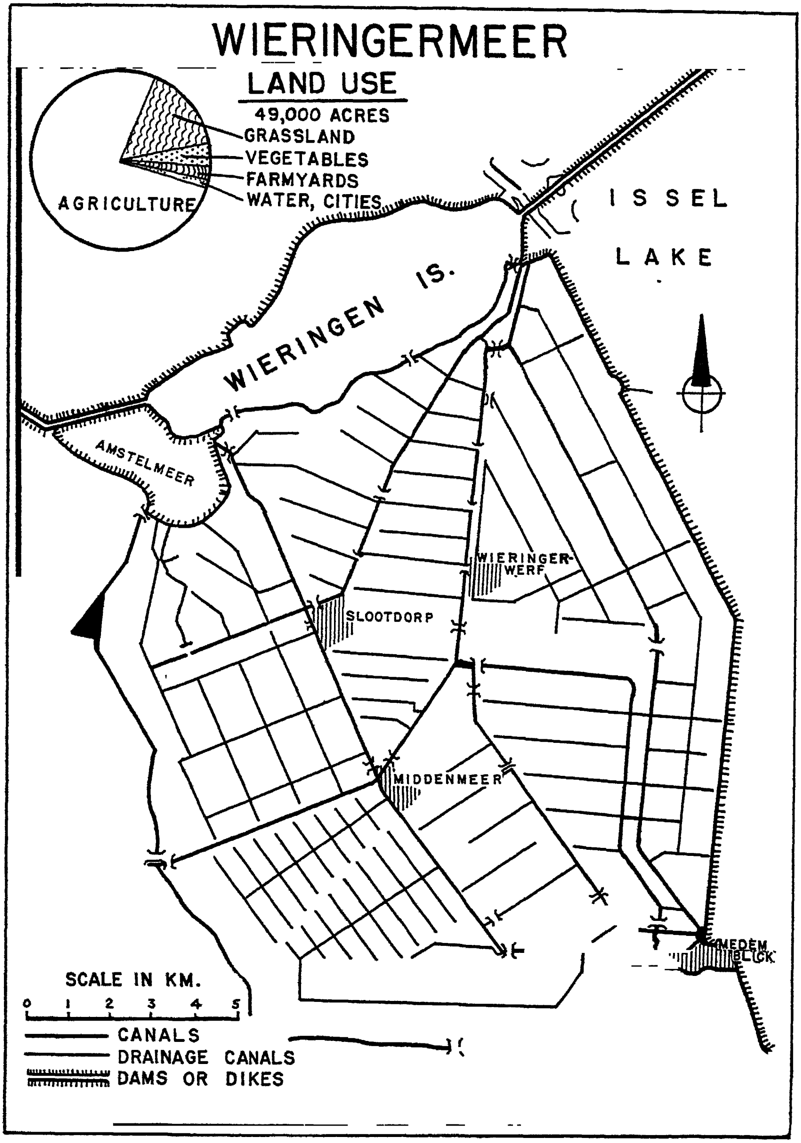

FIG. 4. Wieringermeer (modified from the base map of the Netherlands Information Bureau)

this area 44,500 acres, or 90 per cent, have been brought under cultivation; 5,000 acres are used for roads, villages, canals, and forests.

From 1938 to 1940 the cultivated areas of the polder were as follows (Fig. 4): 77 per cent for agriculture, mainly wheat, rye, oats, barley, peas, flax, potatoes, sugar beets, beets for cattle food, and hay; 17 per cent as grassland for dairy purposes; 4 per cent for fruits and vegetables; and 2 per cent as farmyards.[9]

In comparing production of the Wieringermeer in 1938–40 with American production for the same years, we find its output per acre much higher than that in the United States. Its average yield of wheat was 61 bushels to the acre as compared with the average of 17 in the United States and 22 in Michigan; it averaged 46 bushels of rye per acre as compared with 12 in the United States and 13 in Michigan.[10]

TABLE I

AVERAGE PER ACRE YIELD, IN BUSHELS, OF GRAINS AND POTATOES IN HOLLAND AND IN THE UNITED STATES, 1938–40

Crop	Wieringermeer polder	The Netherlands as a whole	Michigan	United States
Winter wheat	61	51	22	17
Spring wheat	56	34	..	..
Rye	46	29	13	12
Barley	57	..	24	23
Oats	111	84	35	31
Potatoes	421	330	101	132

Source. — Communication from Dienst van de Zuiderzeewerken and *Statistical Abstract of the United States,* 1948.

OTHER POLDERS OF THE ZUIDER ZEE PROJECT

Besides Wieringermeer, Urkerland polder, covering an area of 118,000 acres and including the island of Schokland, has been completed (Pl. II, Fig. 1). Owing to the war it took much longer to build this polder, so that the land was not leased until the fall of 1947. The parcels in it are somewhat larger than those in Wieringermeer, being 900 by 2,400 feet. The lack of building material retards rapid development of them. During 1947 most of the polder was still being developed by the state, and numerous camps dotted the landscape.

Two other polders in the Zuider Zee are to be reclaimed in the near future, one, the Southwest, covering an area of 132,200 acres, and the other, the Southeast, an area of 260,000 acres (Fig. 3). The four polders together will form Holland's twelfth province, with a total of over 560,000 reclaimed acres.

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[9] Data received from the Dienst van de Zuiderzeewerken.

[10] *Ibid.*

The reclaiming of land of such dimensions brings new and different problems. As a result of the experience gained at Urkerland, future plans include construction of a canal one and one-half to two miles wide between the new polders and the original land. In this way it is hoped that seepage of subsoil water into the new polders from the higher mainland can be avoided. To prevent rotting of the foundation piles of Amsterdam by drying, a waterway between Amsterdam and the newly constructed polders will be left.[11]

With the establishment of the four polders in the Zuider Zee its entire economy and purpose have changed. The new fresh-water lake, with a total area of over 300,000 acres, provides drinking water for cattle, a matter of special importance between April and August, when it was usually dry. The water of Ijsel Lake will be available at all times for agricultural and industrial purposes, and also for inland transportation to North Holland and the Friesland provinces. The surplus water can always be discharged through the sluices into the Waddenzee and so into the North Sea. The simplified control of flood and storm waters in the new lake will dispense with the costly maintenance of hundreds of miles of sea dikes in the Zuider Zee. At present only about twenty miles of the main enclosing dam needs careful attention. The damming of the Zuider Zee made necessary the raising of all banks of the Waddenzee to combat higher storm tides, a project much less expensive than the constant attention required by the intricate system of canals and lakes of North Holland and Friesland.[12]

WAR DAMAGE AND REPAIR

Toward the end of the war the Germans prepared to flood the Wieringermeer and Urkerland polders. When Allied troops arrived at the eastern point of the Afsluitdijk dam in Friesland in the middle of April, 1945, the Germans flooded the Wieringermeer by blowing up the dike seven miles south of Den Oever. The polder was flooded in two days by water which reached a height of about twelve feet (Pl. III). A storm a few days later caused additional damage. At the same time that the water of Ijsel Lake flooded the polder, the Germans opened the sluices at high tide and salt water entered the lake. They had also prepared to dynamite holes in the Urkerland dike, but they were prevented from doing so by Polish workers. This action saved the larger of the two polders. Each of the two gaps blown in the Wieringermeer dike widened to almost 600 feet, with 90 feet of the dam left between them. An eyewitness described "the unending caravans of farmer's wagons, packed in haste with furniture." Only 60 houses on the 512 very modern farms built since 1935 were left, and 40 of these were damaged.[13] Three villages of 1,100 houses disappeared (Pl. IV). There was no further harvest on this polder until 1946. The timber framework of the barns was much more resistant than brick walls were, and the frames still remained in the summer of 1948.

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[11] *The Zuiderzee Works, the Work of Half a Century Told in Five Minutes,* the Netherlands Government Information Service, 1947, pp. 15–16.

[12] Data received from the Dienst van de Zuiderzeewerken.

On June 21, 1945, the rebuilding of the dike was started, and on August 5 the two gaps were closed. The dike now forms an arc around two small lakes, which will remind later generations of the destruction brought about by the Germans (Pl. II, Fig. 2). In the future a national park with a forested area will be built on the sandy plain near these two lakes.

A few days after the dike had been repaired the pumps which had remained intact, together with auxiliary pumps, started for the second time within a generation to drain the water from the polder. The draining was completed in less than six months. Speed was important because, though every house had been destroyed, it was possible by pumping fast to save roads, bridges, and canals which would have been quickly destroyed had the water level subsided slowly and so allowed the waves to scour the bottom. Since the damage from the salt was slight, it was possible to reseed the polder in the middle of April, just one year after the bombing. Only 3,500 acres[14] near the gap remained untillable when I visited the polder during the summer of 1948. The rebuilding of the farmhouses is hindered by the lack of modern machinery, and also of building material, which is allocated equally to all destroyed areas throughout the Netherlands. According to the latest reports, nearly all the 44,500 acres will be cultivated during 1949.

LAND SUBDIVISION AND OWNERSHIP

All land and farms in the Wieringermeer polder are leased for terms. The Wieringermeer was reclaimed and brought under cultivation by the State, and the initial cultivation was likewise carried on by it, until there was sufficient assurance that use of the land entailed little or no risk for private owners. After a few years the Wieringermeer gave yields equal to and often better than those of the rest of the Netherlands. The new farms were attractive, well parceled, had excellent drainage, and the rent was low the first two years. Gradually it increased until the fifth year, when it was comparable to that of similar lands elsewhere. Farmers to whom the land was leased were carefully selected both with regard to their experience on farms and their possession of working capital.[15]

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[13] *Ibid.* and interviews during the summer of 1948.

[14] Letter from Mr. Geers, March, 1949.

The farms in the Wieringermeer comprise between 20 and 250 acres, but more than half are under 100 acres, and the majority have 20 or 30 to 100 or 125 acres. At the present time the Wieringermeer has 226 agricultural farms, 239 mixed agricultural and grassland farms, and 26 grassland farms, a total of 491 farms, in addition to 37 experimental farms managed by the State, with a total area of approximately 2,470 acres.[16] Each State farm is leased to a farmer. The responsibility is in the hands of the management of the Wieringermeer polder, supervised and directed by an inspector. Machinery used during the period of State cultivation and on the State farms belongs to the State, but several private farmers own machinery jointly. As in other Dutch agricultural areas, much machinery was damaged during the war and considerable work has to be done by hand, a situation that lowers at present the total output per acre. Through the Marshall Plan new machinery, especially tractors, is purchased from the United States.[17]

SETTLEMENT PLANS

The Zuider Zee project has focused attention on the many population problems in relation to recent land reclamation. Holland's population increased from six million in 1910 to ten million in 1947, approximately 66 per cent, whereas her agricultural land has increased only 11 per cent.[18] In the new Zuider Zee project it was decided to establish a regional center for from 30,000 to 40,000 people and for numerous smaller towns and rural villages. It is estimated that upon completion of the project about 300,000 people will live in these reclaimed areas in a proportion of 2 : 1 in favor of farmers as against other classes.[19] According to Mr. de Blocq van Kuffeler, director of the Netherlands Association for Land Reclamation, "the newly created land will absorb only a very small part of our growing population. It is generally accepted that in large newly reclaimed areas there should be one inhabitant per 2.5 acres, including nonfarming members of the community. At this rate a large area such as the southern polders would in the long run not be able to absorb more than our population increase of one and one-half years. But a large area like this will also create all sorts of opportunities for work all over the country, so that it will give employment to far more people than those settled in the polders, but the reclaiming of new territory will never absorb the surplus population . . . ."[20]

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[15] For the Wieringermeer, farmers had to have fifty dollars per acre as working capital. As much as two thirds of it could be borrowed from special farm coöperative banks.

[16] Dienst van de Zuiderzeewerken.

[17] Personal interviews and correspondence with the Dienst van de Zuiderzeewerken.

[18] 5,625,000 to 6,250,000 acres.

Land reclamation offers "a direct opportunity to extend the agricultural area. New territory may be entirely adapted to the requirements of scientific farming, thus making economic development and low cost of production possible, a factor of the utmost importance to the Dutch economy."[21]

FUTURE PLANS

New usable land can come only from reclaimed wasteland and by reclamation from water (Fig. 3). Anyone who has visited Holland will readily agree that wasteland no longer exists. Upon completion of the reclamation of the Zuider Zee, 560,000 acres of valuable soil will be available, an increase of 7 per cent of the total area of the country and 10 per cent of the total arable land. Though, as noted above, this new land in itself will not take care of all the country's surplus population, it will contribute to the total agricultural production in a country which has a high birth rate and from which few people emigrate to find new homes.

The Netherlands Association for Land Reclamation, a privately sponsored organization, and all government departments work unceasingly on plans for additional land-reclamation projects. The Association "visualizes one continuous coastline from the Belgian border to the German frontier . . . ."[22] This project would reclaim all the land in the southwestern province of Zeeland, the waterways and sandbanks of South

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[19] Data given in a lecture by Mr. A. A. van Rijn in Rotterdam, "Social Conditions in the Netherlands," August 2, 1948.

[20] Kuffeler, V. J. P. de Blocq van, "The Importance of the Reclaiming of Land for Our National Recovery," *Economische-statistische Berichte*, Jan. 8, 1947, No. 1548. [21] *Ibid.*, p. 3.

[22] *Netherlands News Letter* (as cited in note 1), p. 20.

Holland, together with all the islands along the Frisian coast. As the Association states in one of its announcements: "The only gaps in this coastline would be the locks in the waterways giving access to the ports of Antwerp, Rotterdam, and Amsterdam. Behind the coastline, virtually every waterway, except those needed for drainage, would be reclaimed."[23] Further plans are being made to reclaim the Waddenzee of North Holland,[24] which, together with the land now beneath the Zeeland waters in the southwest, would add 950,000 acres of soil. The reclamation of the Waddenzee, which is partly exposed at low tide, would not only add new farm land, but would also prevent sea water from coming up the tidal rivers and depositing salt in the old and the new polders.

Though realizing the tremendous expenditure needed for materials, labor, and capital, and the scarcity of many commodities essential in the reclamation processes, the Association, as well as many Dutch people, believes that, even though costs are high, it is of the utmost importance for the future of the Dutch to continue the struggle against water, to improve and add new land, and in this way to further the recovery of the national economy.[25]

APPRAISAL

After many conferences with Dutch officials and after considering the nature of the country and its economy, I believe that, regardless of costs, the Zuider Zee reclamation project and other similar projects planned for the future are not only technically feasible, but are also necessary for the continued progress of the country.

The Netherlands depends on a constantly increasing acreage under cultivation to feed its growing population. The holding of food imports at the lowest possible figure is essential to the economy of the country. In addition, many foodstuffs grown in the Netherlands provide raw material for Holland's factories. The changing of the map of the Netherlands is accomplishing its purpose.

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[23] *Ibid.*, p. 20.

[24] Located between the isles before the Frisian coast and the coast itself.

[25] The Netherlands Central Planning Bureau proposes to spend in the next five years 1.8 billion guilders ($720,000) and hopes to place 300,000 new workers annually. Though the actual costs of reclaiming the two southern polders of the Zuider Zee are "now 2½ times higher than in 1939, it will demand only 1¼ per cent of the annual investment and one per cent of the workers." *Netherlands News Letter* (as cited in note 1), p. 20.

PLATES I–IV

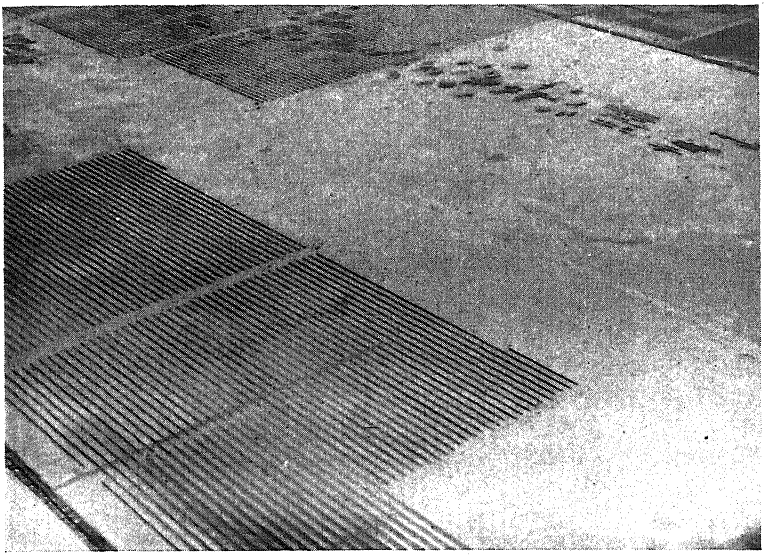


FIG. 1. Mechanical trenching; aerial view
(Royal Dutch Airlines [K.L.M.])

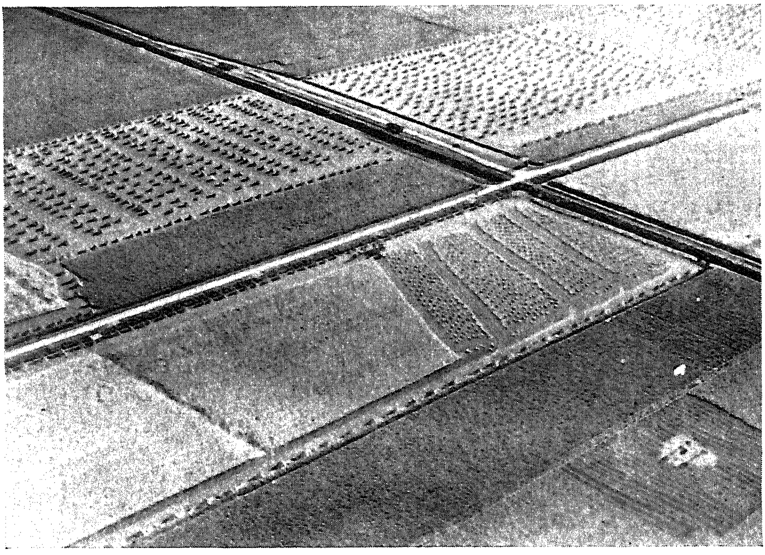


FIG. 2. Wieringermeer, cultivated land, 1948
(Royal Dutch Airlines [K.L.M.])

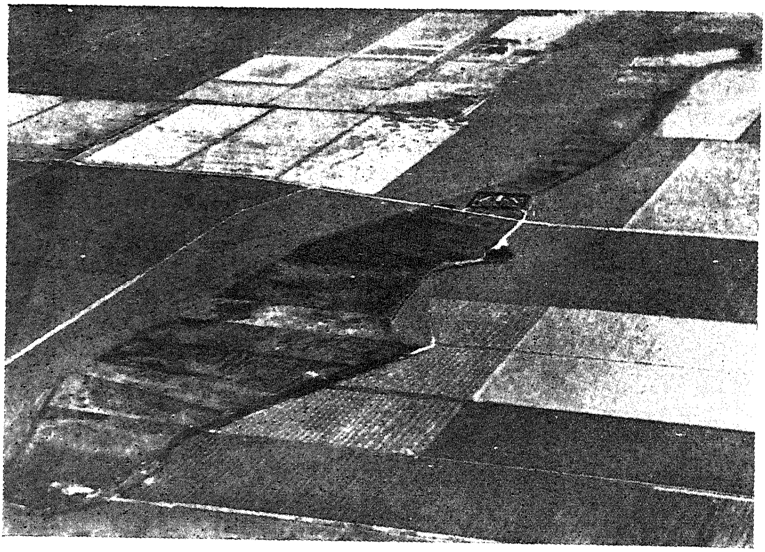


FIG. 1. Urkerland, with former Scholand Island, 1947
(Royal Dutch Airlines [K.L.M.])

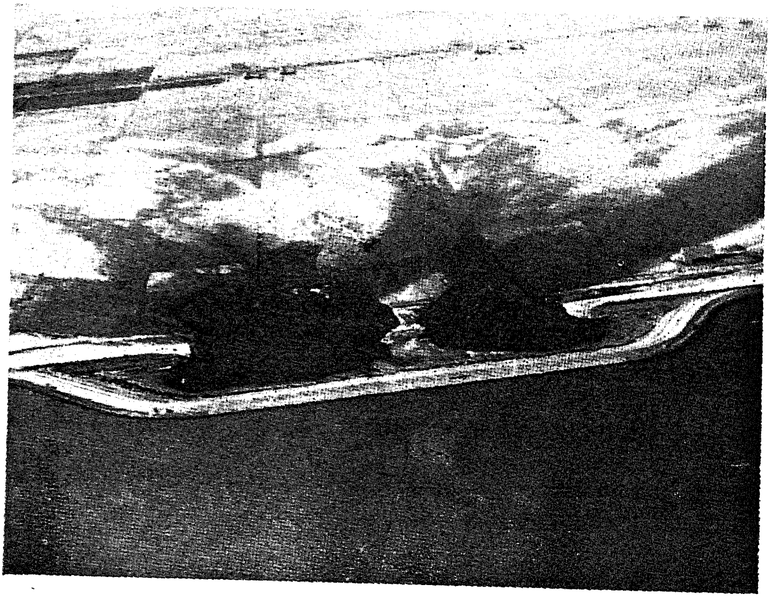
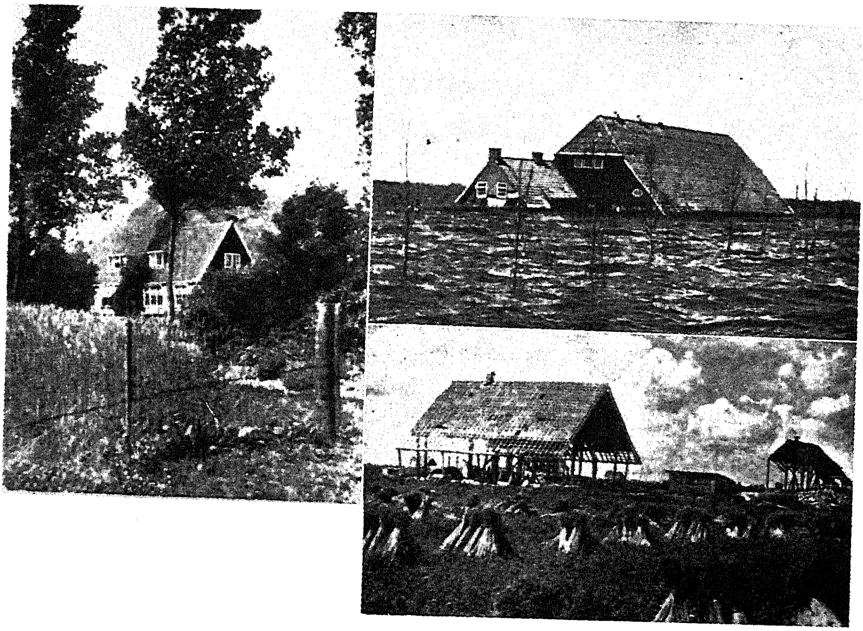
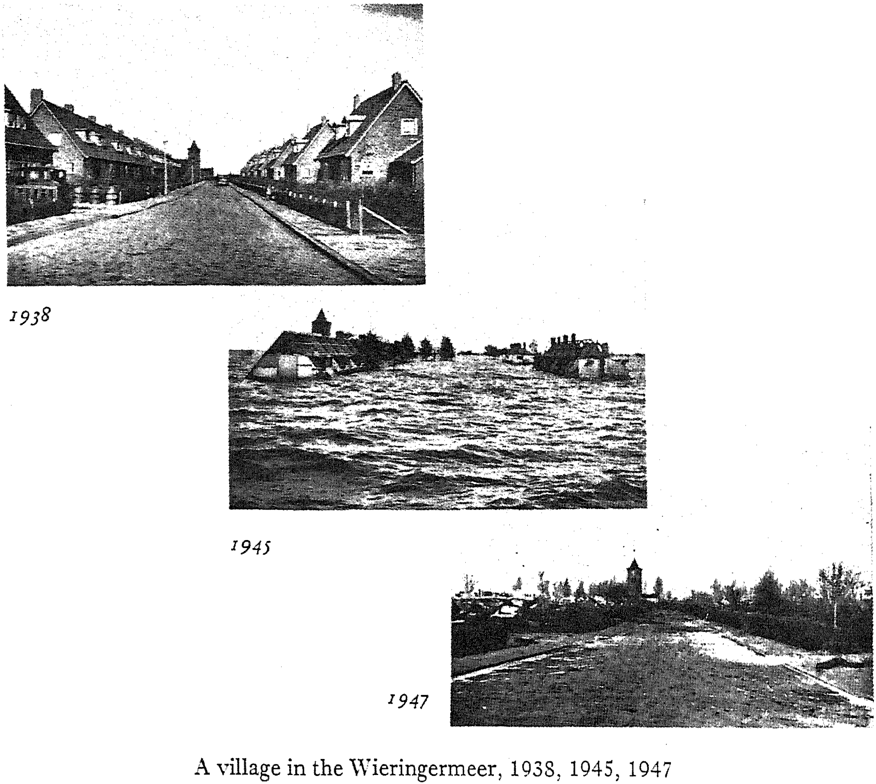


FIG. 2. Reconstruction of the Wieringermeer embankment
(Royal Dutch Airlines [K.L.M.])

PLATE III



The Wieringermeer before, during, and subsequent to the flooding
(Official Netherlands photograph)



1938

1945

1947

A village in the Wieringermeer, 1938, 1945, 1947
(Official Netherlands Photograph)

THE BEAVER ISLAND–WAUGOSHANCE POINT AREA OF MICHIGAN

A STUDY IN UNPLANNED RECREATIONAL DEVELOPMENT

JOHN H. McMURRY

INTRODUCTION

THE State of Michigan, with its thousands of inland lakes, small streams, rivers, and extensive forest tracts, has become a recreational mecca. It is among the nation's leaders in the number of hunting and fishing licenses sold and also in the number of tourists that visit it. One of its great attractions is its position with reference to the Great Lakes, all but one of which touch its shores. It has more miles of shoreline than any other state in the nation, and there is also the lure of numerous islands that belong to the state.

It is true that isolation and inaccessibility have hampered the recreational use of some areas, but when it is shown that a resource exists, development may follow in spectacular fashion. Such a development, together with a consideration of some problems involved in it, may be illustrated by a study of the Beaver Island–Waugoshance Point area (Fig. 1).

THE SETTING

Waugoshance Point is at the extreme northwest tip of Michigan's Lower Peninsula. It extends westward into Lake Michigan for twelve miles, and is composed of a series of long, narrow islands, culminating in a larger one called Crane or Waugoshance Island. Continuing westward some fifteen miles over a shallow rock shelf one reaches Hog Island, the most easterly of the Beaver Island group. This group of eight islands spreads over nearly 525 square miles of northern Lake Michigan.

Beaver Island, the largest of the group, is thirteen miles long and six in width. Garden Island, the next largest, is five miles long and three in width. Hog and High islands are approximately the same size — roughly ten miles in circumference. Gull, Whiskey, Squaw, and Trout islands are all much smaller, ranging from one-half to one mile in circumference. The entire region is underlain by limestone, which has been slightly tilted and dips gently to the east. Outcropping at the surface and under water has caused the formation of numerous shoals and reefs over much of the water surface of the area. The shorelines of the islands and Waugoshance Point are rough and broken, being everywhere characterized by numerous bays, channels, and inlets, and small offshore islands. The generally shallow water and the nature of the lake bottom, a heterogeneous mixture of sand, pebbles, rocks, and huge boulders, necessitates extreme caution in the handling of even the smallest boats.

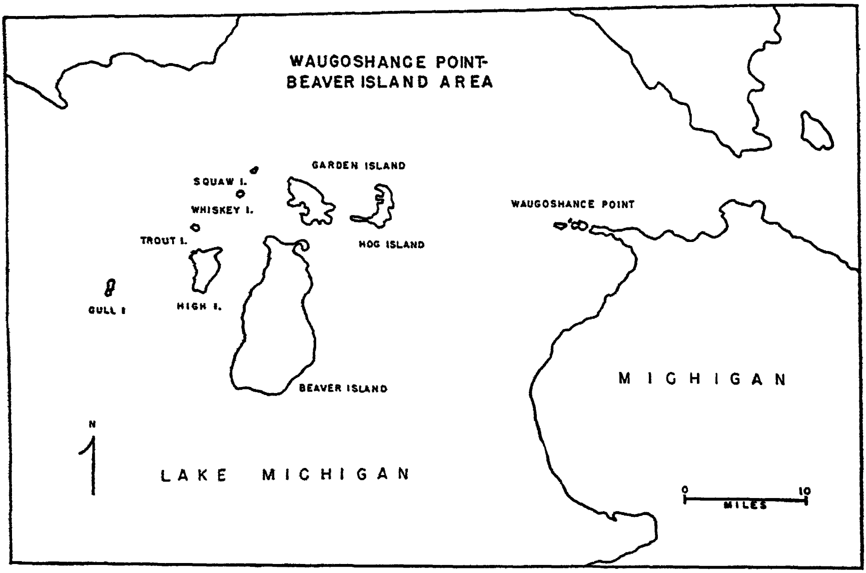


FIGURE 1

Such, then, is the locale of our present discussion. Until recently it was an area of extreme isolation. With the exception of limited agriculture and tourist trade on Beaver Island, it has been almost exclusively devoted to commercial fishing and scattered lumbering operations. It is now, however, the scene of a rapidly developing situation without parallel in the history of recreational use in Michigan.

THE DEVELOPMENT OF BASS FISHING

In the past commercial fishermen operating in the area were concerned mainly with such valuable species as whitefish, lake trout, herring, and perch. They looked upon the large numbers of bass taken in their nets as a nuisance. During the depression of the thirties, however, a program set up by the Michigan Conservation Department attached considerable importance to these fish. Fishermen were paid ten cents a piece for bass. They were caught in trap nets, kept in live boxes, and ultimately picked up by the Department and transferred to inland lakes. With returning prosperity fishermen again found it more profitable to concentrate on market fishing. Thus the program was abandoned in 1937.

Since there is ample evidence that large numbers of game fish are present, it is difficult to understand why the area was not speedily utilized by sportsmen anxious to tap the supply. The combination of public unawareness of the resource, isolation, and difficulty of access, together with the war, seem to have effectively blocked any large-scale opening up of the region.

During the summer of 1946 conditions changed. Returning veterans and others on extended vacations "discovered" Waugoshance Point. Tales of huge fish and limit catches spread, and by the end of the summer word had been passed around that here was indeed a sportsman's paradise. The next two years witnessed a remarkable transformation that at the outset would have seemed almost fantastic. Through the summers of 1947 and 1948 cars bearing license plates of practically every state in the Union parked at the base of the Point. Informal spot checks showed that from 25 to 150 cars were present on every day of the week. Small boats manned mostly by navigators unacquainted with the hazards of the area jockeyed for the best fishing sites. Charter plane services from Petoskey, Charlevoix, Harbor Springs, and as far distant as Traverse City filled the airlanes. Passengers were discharged carrying equipment ranging from bathing suits to rubber boats. This beehive of activity was not confined to Waugoshance Point alone. Yachts, planes, outboard motorboats — every available facility was used in exploiting the fishing grounds of the Beaver Island group as well. Beaver Island itself served as a base of operations. Its two hotels, one restaurant, and tavern (which shortly ran into competition with another tavern opened up next door), were taxed to the utmost in servicing the hordes of sportsmen descending upon them. The two neighboring islands of Garden and Hog were speedily overrun, and commercial fishermen in the vicinity were hampered by fishing parties fouling nets and shearing off net stakes. Landing and taxying airplanes further disrupted operations, while adventurous individuals explored the islands, peeling birch bark and often creating fire hazards. Small boats got into difficulty during bad weather, and the Coast Guard Station at Beaver Island called for additional personnel. A small lake on High Island teeming with pike, perch, and pickerel was located and emptied of everything but bullheads. Within a short time the more remote islands had been investigated, but shoreline and bottom conditions there are different, and few bass were taken. As the 1948 season closed, hundreds of fishermen declared that the following year would see even greater activity.

THE PROBLEM

Numerous questions have been posed by this large-scale occupation of a region which formerly made up one of the few essentially virgin outposts left in the state. Aside from the destruction of certain esthetic values attached to it by many people, other problems of a more concrete nature have arisen.

The only land route leading to Waugoshance Point is a twisting one-lane dirt road which passes through the heavily forested western extension of Wilderness State Park. Having been designed to handle only limited traffic, it was quickly reduced to an almost impassable state by the heavy flow of sportsmen anxious to reach the fishing grounds in the shortest possible time. Thus the establishment of transportation facilities was one of the first problems met. To date (March, 1949) this situation has not changed.

Enforcement of fishing laws and regulations, as well as general supervision of the region, is impossible under present conditions. It is certain that inadequacy of personnel for patrol work and disregard of bag limits have combined to allow an enormous seasonal catch. Whether it is possible to overfish such an area is but one of the many questions that arise. And a noticeable decline in the take toward the end of the 1948 season leads to considerations of cycles of abundance in the fish population. Food habits, the effect of fluctuating lake levels, and the increased incidence of lamprey-scarred bass are only a few of the many other problems that confront the specialists in fish management.

Fire control is particularly difficult because of the almost complete lack of equipment and an organized fire-prevention plan. The fortunate circumstance of comparatively wet summers during the last three seasons has precluded any disastrous fires. A dry summer, however, could very well result in extensive damage.

CONCLUSION

In view of the income that has accrued to the state through the use of the Beaver Island–Waugoshance Point area, its importance as a recreational asset should be obvious. It would therefore appear to warrant far greater attention on the part of those Michigan agencies concerned with such matters.

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SETTLEMENT EXPANSION ACROSS DETROIT'S NORTHERN METROPOLITAN RIM INTO SOUTHWEST MACOMB COUNTY*

FLOYD A. STILGENBAUER

THE landscape adjacent to Detroit, geographically known as the umland, is passing through definite stages in changing from rural to urban use. A map showing the occupance patterns of a district extending across the northern metropolitan rim into southwest Macomb County presents conclusive evidence concerning the extent and manner of expansion of the morphological structure within this large metropolitan city. Urban impacts during the growth of Detroit on the rural umland resulted in high land values, increased tax levies on property, loosely managed speculation, and easy credit on loans. Forced improvement of properties made at the owners' expense, incomes augmented by supplemental activities, agreements with management to pay more lucrative wages and grant greater labor benefits were coetaneous elements involved in the process of settlement. This field study reveals how general farming is disintegrating inwardly where the soil will no longer yield an adequate income without a more intensive use of the better land for market gardening, fruit raising, and the cultivation of flowers and nursery stock, or some added form of industry like poultry husbandry, rhubarb producing, and the raising of rabbits, dogs, and mink. Lands less suitable for agricultural improvement and those occupying the more advantageous positions in the transportation form are taken over or reserved for industrial development, which is the major force producing urban growth. Forest remnants and natural beauty spots are frequently utilized for recreation or for home-building sites.

On the outer margin of the district about Utica — formerly called McDougell, Hog Hollow, and Harlow — a strong rural impact on a weaker urban influence results in the retention of more nearly normal farm activities. The only manufacturing in the village is done in two old water-power mills that use raw materials produced on the land. In one, wheat is rolled to make Gold Lace pastry flour for the nearby market, and in the other, grain is ground into feed for the livestock on local farms.

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* The cartographic work for this paper was done by George Kaston, Wayne University. Noreen Barton, Robert Basal, Robert Brodowicz, Ann Chikos, George Kaston, Robert Kelley, Sidney Rose, and Alphonse Trawinski assisted in the collection and presentation of field data.

This study is also concerned with the manner of increase in the urban population. Detroit's growth is accomplished (1) by additions in areas within the central nucleus, where settlement is already far advanced but where potential capacity has not been exhausted, and (2) by the rise of small inhabitation clusters within the contiguous umland, which becomes part of the metropolitan area on sufficient assemblage of occupance. When factories are built, demands for housing mount, and the vacant spaces within the inner confines of the city gradually disappear. Homes, civic buildings, commercial establishments, service shops, and public institutions are placed on lands with natural conditions most favorable to their needs in the urbanization plan. It is the ingathering of dwellers on community sites having physical and cultural advantages for business assemblage that causes population to grow upward and outward, increasing the density and adding to the size of the metropolitan center as a whole. From the pressure of growth about the core stems a definite movement of people toward the periphery or to the surrounding suburban, suburban-rural, and rural districts in search of more satisfactory living conditions.

The 1940 census enumerated a tremendous increase of habitation throughout the inner metropolitan rim of Detroit. To judge from more than a decade of observation and study of urban chorography, it is presumed that the 1950 census will show an even greater settlement expansion outside the central city than did the previous one. It is difficult to estimate how much of this growth has been due to migration within, or what percentage of it has been accomplished through additions from outside. Outward expansion of the population has been most rapid and hence nearly complete along such major arterial highways as Lake Shore Drive, Gratiot, Woodward, Grand River, Michigan, and Jefferson avenues. Here the metropolitan rim juts outward from twenty-four to forty miles from the city hall. The interareas where subarteries lead to the main trunkline highways or to the central core of Detroit present a noteworthy increase in the number of inhabitants. This is a typical example of the outward urban growth during the past ten years.

A detailed chorographical survey and a thorough geographical study of a strip of landscape crossing Detroit's northern metropolitan rim along the inner umland were made in the summer of 1948 (Fig. 1). The area consists of the western half of the townships of Warren and Sterling in southwest Macomb County, which lies astride the Michigan Central Railroad and includes the incorporated communities of Center Line, Warren, and Utica. This area of approximately thirty-nine square miles is three miles wide and thirteen miles long. It reaches eastward from Dequindre to Van Dyke Road and extends northward from Detroit's upper border, Eight Mile Road, to Twenty-one Mile Road above Utica. This tract was chosen because the district avoids the direct influence of major trunk-line highways and depicts the more natural relationship of Detroit to its northern environs, where settlement appears to be expanding most rapidly.

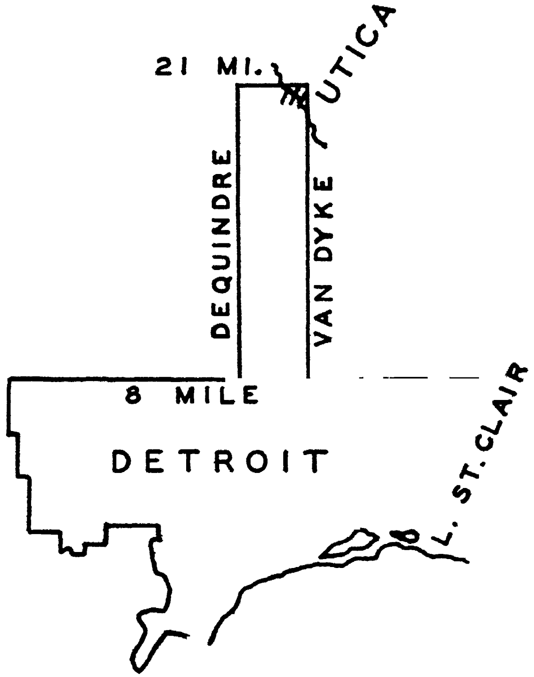

FIG. 1. The area across Detroit's northern metropolitan rim, bounded by Eight Mile, Twenty-one Mile, Dequindre, and Van Dyke roads

In the Macomb district transportation lines are generally good, with each north-south road surfaced with concrete and with each east-west mile road similarly paved or otherwise improved and graded. Highway improvement was stimulated by (1) cheap gravel from the glacial outwash immediately west of Utica, (2) by abundant cement from limestone and iron-furnace slag produced in Wayne County, and (3) by the rise of the motor-vehicle industry in Detroit. On the interior of the square-mile sections the roads vary from bad to good, depending upon the stage and standard of subdivision development.

Natural landscape conditions are suitable for urban expansion in this area. The land surface, with remnants of ancient sandy beaches of the Pleistocene epoch, is flat to gently undulating and is traversed by the more youthful Red Run, Bear, and Plum creeks, which are tributaries of the older intrenched Clinton River. This gentle slope of the land, together with the argillaceous sediments in the subsoil of lacustrine origin, slows up the movement of ground water to such an extent that pools remain in the hollows for a considerable time after heavy rains.

Natural drainage in many places becomes sluggish because of a high water table in the broad shallow depressions. This condition necessitates construction of artificial ditches with county financial aid. The retarded movement of water appears to be the chief factor impeding efficient use of the land for production and building. On the other hand, intrenchment of the Clinton River with retreat of the glacial ice provided a lower outlet for the artificial drainage needed to improve the moisture condition of the land.

The soils fall into two main types: (1) sandy, silty loams and (2) clays and clayey loams. The former are general throughout the western two thirds of the district as far north as Red Run and also in the extreme northeast along the Clinton Valley. Fertility varies according to the amount of silt and loam present, and the lands that are well drained are suitable for agriculture and subdivision development. Heavier clayey lands predominate in a belt about one mile wide extending along the southeast border, across the north-central portion, and thence northward beside the western boundary. Although the heavier soils, when drained, are more adapted to general farming and industrial development, both types are well suited to market gardening in areas where a loose loamy texture exists in the presence of gravel, sand, and silt.

The climate of the district is typical of the glaciolacustrine plain between Lake Huron and western Lake Erie, where the temperature averages 48.5° F., and the annual rainfall is 32 inches. Since the area is situated in the Great Lakes trough, the atmosphere is humid, and the summers are generally moist, with cyclonic rains, thunderstorms, and squalls alternating with fair-weather sunshine. Winters are variable, with days of snow, sleet, rain, slush, glaze, and occasional high winds interspersed with days of bright sun. Tempering influences from the lake waters provide some protection from late frosts. Paper nightcaps are used extensively over plants by truck farmers during the danger period of early spring.

Originally forested with broadleaved deciduous hardwoods, the district now has only remnants of them in the woodlots toward the center of many of the sections. Such woodlands are used today for grazing, firewood, recreational parks, tourist camps, and residential subdivisions. Some of the hollows, which were rather swampy, contained scattered conifers among a dense stand of other trees. Cutting of the timber followed the founding of Detroit in 1701. In the decades after the turn of the nineteenth century there was vigorous activity for emigration to Michigan. Widespread settlement and development preceding a later intensive trend made the removal of the merchantable timber necessary for use in the construction industry and for clearing the land for sustenance agriculture.

The settlement of the Macomb district started as early as 1820; it began from Base Line Road and the right-angle roads of Dequindre, Ryan, Mound, and Van Dyke, which were laid out after the Northwest Territorial surveys divided the land into square-mile sections. East-west as well as north-south roads were cut through the forest along the section lines. Families purchased the timberland for a few dollars per acre and settled along the roadways. In the early days of development there were frequent building bees in which pioneers, with the aid of kind neighbors, constructed houses and barns with lumber and timber cut from the forest. Frequently settlers established their homes near a school, church, or store, located at the cross roads or at attractive sites on the higher and drier ground. During the past three decades many subdivisions have been developed in such locations and have spread to the interior of the square-mile sections, with strong expansion pressure from the south.

The growth of population was slow until about 1920. In 1870 there were 3,487 inhabitants, almost equally divided between Warren and Sterling townships. The Macomb district has about half of them. A slow but gradual increase took place up to 1920, when the census enumerated 5,293 persons. By 1930 the population had risen to 16,731 individuals, of whom 14,269 were in Warren Township because of its proximity to Detroit. The 1940 census recorded 25,774 people, with 22,126 in Warren Township, 3,198 in the incorporated communities of Center Line, and 1,022 in Utica. Stimulated by World War II and the industrial expansion northward along the Michigan Central Railroad, occupance has shown a further marked advance during the past ten years.

The rural impact on the virgin timber area caused grazing and general agriculture to increase as lumbering operations, extending over more than a century, gradually dissected the forest into small woodlots. Lumbering and subsequent agriculture brought only a limited prosperity and growth to Center Line, Warren, and Utica. When the more intensive urban impact of expanding Detroit set in with the turn of the twentieth century, southwestern Macomb County was a district of general agriculture, emphasizing the raising of hay, grains, roots, and livestock. The tempo of the recent northward industrial impact is increasing. Strong demands for urban expansion are being placed on the Macomb district. A geographic inventory of the present landscape conditions in this area will serve to show the direction, nature, and extent of settlement expansion across Detroit's northern metropolitan rim, and will reveal the accompanying adjustments of cultural activities to the changing environment.

In presenting the geographic complex the metropolitan rim is divided into inner, middle, and outer portions. The inner division extends from Eight Mile Road to slightly beyond Twelve Mile Road (Fig. 2). Here Detroit's influence was first felt and has been of the greatest proportions. Through site selection, decentralization, and the need for symbiotic relationship between factories of the motor-vehicle business the industrial form has spread miles beyond the limits of the central city. A major arm of the Detroit factory pattern containing several heavy basic manufacturing concerns, together with scores of scattered symbiotic industries, has penetrated the inner section of the Macomb district along Mound Road and the Michigan Central Railroad. Among these heavy industries and adjacent to the railroad right-of-way a transformer station was constructed by the Detroit Edison Company. The station receives 120,000 volts of electricity from the Marysville Power Plant near Port Huron over high-tension lines paralleling the Michigan Central Railroad. This electric power is divided and sent to numerous substations of 4,000 volts each for consumption in the surrounding area.

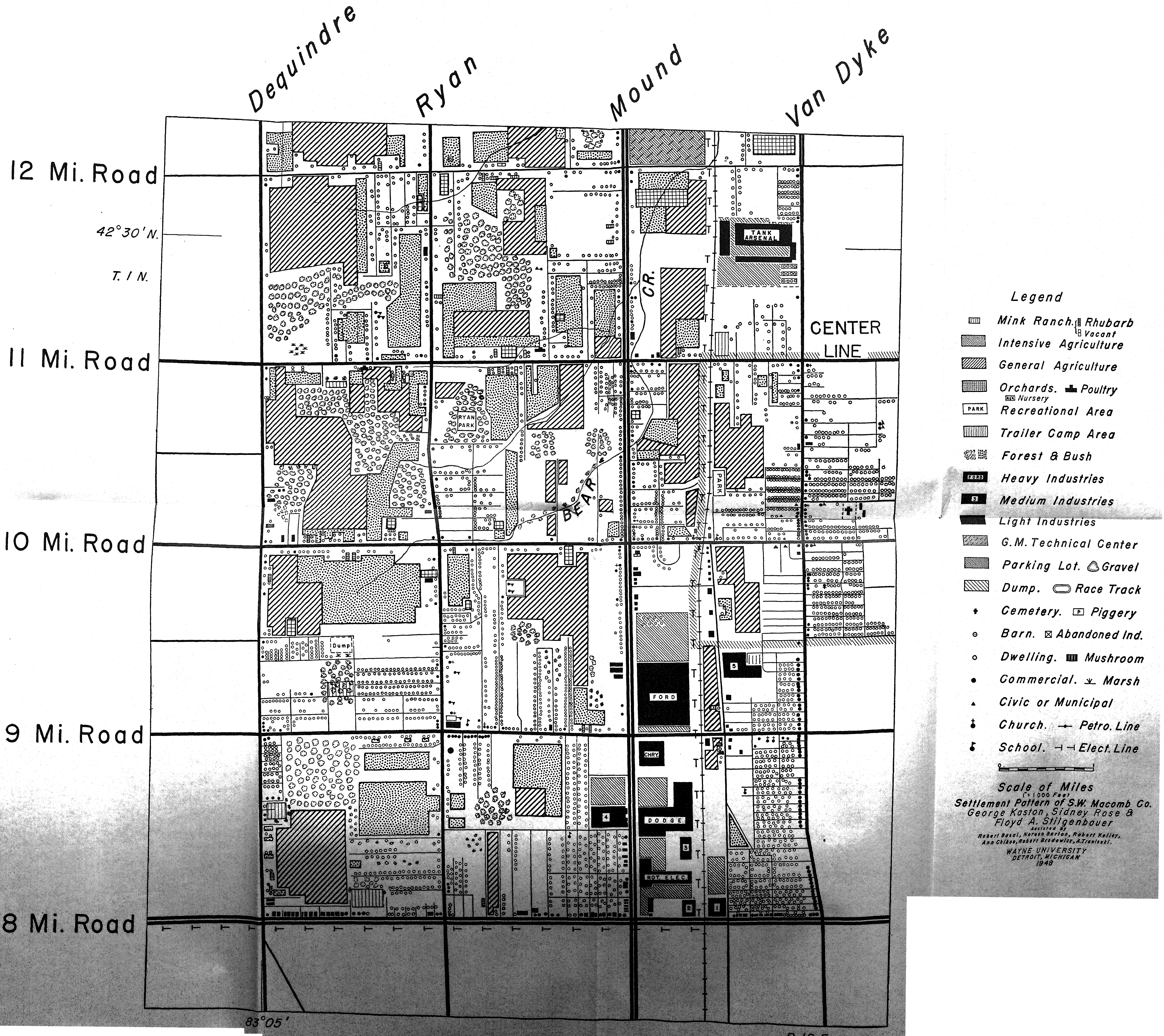

FIG. 2. The inner division of the metropolitan rim, presenting the land-use inventory where the urban impact is greatest

Heavy production began with the building of the Rotary Electric Company plant in 1933. There are over 15,000 people employed in the large plants of this locality at the present time. The division of employment is as follows: (1) the Dodge Motor Truck Company, with 5,200 employees, builders of a large line of trucks and trailers used in transporting goods; (2) the Ford Motor Company, with 4,290 workers, engaged in the machining and forging of certain parts used in the assembly of motorcars; (3) the Rotary Electric Company, with 550 laborers, manufacturers of stainless rim steel by means of electric-furnace processing; (4) the Chrysler Corporation Press Plant, employing 1,000 workers in the stamping of steel into motor-vehicle parts (Pl. I, Fig. 1); and (5) the Detroit Arsenal, north of Eleven Mile off Van Dyke, with 4,200 employees, where tanks are manufactured for the United States Army. Among a large number of symbiotic plants with varied employment are the Canfield Mounting Service Company, the Galion Hydraulic Hoist and Bodies Company, the Roadway Mounting and Equipment Company, the Schaller Tool and Die Company, and the Model Broach Company (Pl. I, Fig. 2). The names of the latter companies reflect the ties with the motorcar and truck industries.

Along with these establishments came thousands of factory workers and their families, who wanted to be near their place of employment or outside the central city, where they could be close to rural surroundings. Some worked in the local plants, which also drew laborers from the city; others were employed in Detroit. Factory and subdivision development forced general agriculture to decline and disintegrate. Land was first subdivided along the main highways, and later plotting progressed toward the center of most of the square-mile sections.

The largest subdivisions are around the heavy industries. Small poorly constructed houses predominate. Even former dumps were leveled, covered with a thin layer of earth, and converted into subdivisions. Many homes are build on land containing a mixture of earth, tin cans, broken bottles, fragments of cement, and other débris. One small dump still remains on swamp land between Nine and Ten Mile roads off Dequindre. Habitation has pushed dumping operations farther north. Commercials concentrate along the major highways to serve the people more conveniently. Mixed commercials and light industries flank Eight Mile Road on the north; their position outside Detroit enables them to enjoy lower taxes and still have city advantages. Small property holdings adjoining the south side are mostly vacant. Commercials monopolize Van

Dyke frontage to Center Line, except for three sizable vacant spots waiting a greater concentration of homes.

Center Line was founded in 1878. The settlement grew slowly, and for a long time was dependent on Warren for its telephone connection and rural free delivery. When incorporated in 1925, the village had a population of only 300 people. Banking was done in Detroit, and produce was taken to Warren for shipment. By 1930 the population had grown to 2,605, and the community became more independent. Center Line was incorporated as a city in 1931. Favored by close proximity to Detroit, it has grown to be the second largest city of Macomb County, with 3,198 inhabitants in 1940. During World War II the establishment of large factories in the Mound Road district greatly increased the population. Migrants built houses with their own hands because of rising costs. Added housing was provided by the Federal Government Aid, so that a large area of rural land was converted into a thriving community. Serving the Mound Road industrial section, this city will prosper in the future.

High land values, increased taxation for extensive public improvements, and the difficulty of securing farm labor in competition with the highly paid factory workers made profitable general farming impossible. The general farmer was faced with the problem of choosing one of five alternatives. He could (1) intensify the agricultural process through the use of gardening methods if the soils were suitable; (2) turn the farm wholly or in part to other uses, such as cow and goat dairying, poultry and pig raising, horse renting, and providing land for campers; (3) supplement his activities by adding a greenhouse, rhubarb shed, mushroom barn, dog kennel, rabbit hutch, supply depot, roadhouse, and the like; (4) seek other, more lucrative, jobs, such as trucking service, house moving, excavating, and garden plowing; or (5) sell out to a subdivider at a low price after the property had badly deteriorated. If lucky enough to have the right location, he might sell his land for a good price for a factory site.

The impact of industry is being felt severely, and many of the farmers of the inner section have withdrawn from agriculture, although the old farmhouse and the barn may still be occupied. Barns are sometimes converted into stores or shops (Pl. II, Fig. 1). There are a few farmers operating at a loss, but their number declines toward the industrial center and adjacent subdivisions, where the pressure for removal is great. In the extreme southeast the rural influence has all but disappeared.

Away from the industrial center, intensive farming and supplemental activities are quite well developed. There is an excellent market for garden produce, early shed-grown rhubarb, flowers, rabbits, poultry, and other quick turnover products. Horticulture has disappeared from the southern part of the inner section. Since farm orchards declined with general agriculture, this industry could not be reëstablished on account of the long period before the first sizable crop. Even to the north orchards are neglected unless associated with the more intensive activities. Much undeveloped subdivision land is covered with grass, weeds, and brush and is unsightly. Most factory workers do not engage in home gardening to any great extent unless a depression or a manufacturing concern forces it. High wages and long hours of confining work require a less strenuous diversion. Rhubarb sheds become numerous to the west and northwest, and scattered poultry ranches appear. Here one also encounters most of the remaining woodlots, which are sometimes taken over for recreation grounds like the Ryan Park at Eleven Mile Road.

Demands for low-cost housing exceed the supply, and some families find it necessary to live in trailer homes. Six such parks are located in the inner section. The Shady Lane Camp off Nine Mile Road east of Dequindre, which covers three and one-half acres, contains 120 trailers, with an estimated population of 350 people. The proprietor lives in a trailer among his patrons, for this is a lucrative business and requires long hours of personal attention. Rent for a lot is $20 per month, and electricity is charged to the tenant. Water from Detroit reaches each trailer through a pipe with an electrically heated jacket to prevent freezing in winter. Special buildings provide supply, mail, bath, toilet, and laundry services. Meter washing machines are rented to the tenants by the owner. This site is newly developed, and only about thirty to forty per cent of its inhabitants are permanent, but some camps of long standing reach sixty to seventy per cent permanency. The turnover occurs mostly in the fall, when some campers move south to avoid the cold weather, but they return again in the spring to work in the factories nearby.

In the chorography of the middle section of the Macomb district one sees a growing urban influence less advanced, but with high potentiality (Fig. 3). The heavy industries will continue northward along the Michigan Central Railroad, where most of the land is already held by industrial concerns as far north as Chicago Road, paralleling Red Run. On a 360-acre site extending from Eleven Mile Road to Warren village the

General Motors Corporation is building a technical center consisting of five large buildings for experimental purposes. The work was halted by World War II, but construction is now progressing satisfactorily since more plentiful material and labor in the building trades are available.

Warren is in large measure the village it was at an earlier day, except for the means of transportation, but is beginning to reflect the new urban impact (Pl. II, Fig. 2). Selection of the site was made in the 1820's at a point where Mound Road crossed Red Run, and was settled by English, French, Dutch, Belgian, and German families. This incorporated village (580 people in 1940) covers one square mile, much of which is rural territory. A steam feed mill and foundry were the industries around which the town thrived in its early years. Eventually the gristmill and the foundry passed out of existence, and the village sought new industries to give the residents employment. A small factory making welding equipment and a new parts plant, together with a few other light industries outside the limits in the direction of the heavy industrial center, gives the inhabitants ample means of employment. Only one small plant exists in the middle section to the north of Red Run. Warren is beginning to experience some growth and prosperity from the General Motors project.

The only decadent manufacturing industry in the district is the old Trombley Brick Company plant northeast of Warren along the Michigan Central Railroad to the south of Fourteen Mile Road. It operated several years on impure subsoil lacustrine clay of a 160-acre tract, but the bricks became soft and gradually crumbled with age. Competition of better brick from Dearborn and elsewhere caused the concern to go out of business. The pitted land became an idle waste of little value until the urban influence arrived. When dumping areas to the south had been overrun with more valuable types of utilization, Detroit needed a new site for such operations farther out. The city rented the old brickyard property for a small sum and converted it into the largest dump in the metropolitan area. One can readily see how the urban impact converts even waste land to valuable use. In three years after dumping operations are completed the land can be taken over for a building site. Some day homes or factories will rise on this dump, as they have done on numerous others. To the west off Dequindre at Chicago Road, Hamtramck has about eighty acres of dump on the lowlands along Red Run.

General farming is more important in the middle section, where it occupies about two thirds of the available agricultural area. Some farms have a decadent appearance, especially where drainage is sluggish and high taxes for subdivision development are reducing farmers to poverty. Farmers are still making money by feeding ensilage to dairy cows and selling milk at the high prices prevailing in Detroit.

Intensive farming continues from the inner section of Red Run, from where the trend is toward the eastern half of the middle section. Gardening acreage is generally smaller, and all but disappears to the northwest, where soil is heavier and poorly drained. Orchards are numerous, but many are sadly neglected. Outside the intensive area horticulture has vanished through decadence. Similar conditions have been noted in the southern two thirds of the outer section. For the most part the land is too flat, the soil too wet, and too compact because of a heavy subsoil, which retards root growth. Another repellent factor is the presence of maximum frost danger, due to lack of air drainage on these flat lands and the prevailing adverse westerly winds that tend to nullify any tempering influence of Lake St. Clair.

Shed-cultivated winter rhubarb is found throughout the intensive farm areas of all three sections. Around Warren and Utica and toward Royal Oak more winter rhubarb is grown than at any other place in the world. Airplanes and Michigan Central express cars come to pick up some of the supply. In a single season a 300-foot shed may yield a crop that increases income by $3,000.

The accidental dumping of a load of barnyard manure on some rhubarb by a farmer at Seven Mile Road in Wayne County led to the creation of indoor cultivation, which has greatly bolstered a declining general agriculture. The fertilizer had remained on the plants during the winter, and when the farmer returned to remove it in early spring he was surprised to find red stalks of rhubarb growing through a late snow. It was noted by several farmers that the heat generated by rich decomposing manure caused an earlier growth of tender red stems. They set out to establish a new industry inside heated sheds, which were insulated with earth, straw, and manure. Expansion of Detroit forced the industry to retreat northward across Eight Mile Road into Oakland and Macomb counties.

Rhubarb roots are planted outside on good land and allowed to grow two years without any stems being pulled. Then they are plowed up and allowed to remain outdoors under protection until the ground is frozen to a depth of about two inches. They are then placed inside long insulated sheds in earth enriched with a heavy application of manure. The sheds are ventilated and equipped with heating apparatus and watering system, but are carefully guarded from light. Even light from electric bulbs or stoves will cause the stalks to turn green and the leaves to grow large. After six weeks the stalks are ready for harvesting, which begins at Christmas and continues until May. Good timing is necessary to prevent flooding the market.

In the middle section subdivisions are expanding rapidly from the four corners and are numerous throughout the district. They are poor to medium in quality. About one third of the land is idle, which indicates that the owner is planning to subdivide when the time is ripe to reap a fancy profit.

Recreational development is more important where the rural influence predominates and with greater distance from Detroit. Some of the recreational needs of an industrial urban population are met by Carpathia and Magnolia Grove parks, Bar M Ranch, Farmer Jim's Riding Club surrounding an artificial lake in an old clay pit beside the Michigan Central Railroad north of Fifteen Mile Road, Beverly Hills Golf Club in the southeast, and the Warren Aero School on Fourteen Mile off Ryan Road.

Two farms have been taken over for mortuary purposes. Detroit Memorial Park is a Negro cemetery at Ryan Road and Thirteen Mile Road. The Orthodox Greeks have a burial ground at Dequindre and Fifteen Mile Road.

The outer portion of the rim shows the weaker urban impact and, conversely, the stronger rural influence (Fig. 4). The urban relationship is reflected in the rather even distribution of intensive market gardening, poultry husbandry, and dairy farming; also in the more specialized activities such as fattening pigs, raising mink, and the growing of mushrooms, rhubarb, and horticultural products. Fruit is frequently sold along the highway or at a corner market. The better orchards are found in the extreme northwest on the outwash plain, where gravel is an important product. Extensive pits are located along Twenty-one Mile at Ryan Road near the Clinton River. Larger, but less numerous, wooded tracts occur in the west and northwest. General and dairy farms occupy about two thirds of the cultivated land (Pl. III, Fig. 1). Much less land is idle in this part of the district. Only three small industrial plants exist between Red Run and Utica. An airport that uses an old barn for a hanger is situated on Eighteen Mile Road near Mound Road.

One of the outstanding industrial features of this outer section is the petroleum pumping station beside the Michigan Central just south of Utica. It is operated by the Transit and Storage Company, the Ohio-Michigan Pipe Line Division, a subsidiary of Standard Oil. The station assists in moving crude petroleum from the main pipe lines at Cygnet, Ohio, about thirty-five miles south of Toledo, to the Imperial Oil Company at Sarnia, Canada. Other stations on this branch line are at Sylvania, Ohio, and Wayne, Michigan. The company moves crude oil from any field in the eastern half of the United States, and some is also imported from Venezuela, South America. The stations are about thirty-seven miles apart and are linked by three pipes (two 6-inch and one 8-inch) under 1,000 pounds of pressure. In summer crude oil normally moves at the rate of about 45,000 barrels per day. In cold wintry weather the oil gets so thick that on some days the net movement is only 8,000 barrels in 24 hours. The lines are inspected daily for leaks by men walking the routes in search of oil spots on the surface. Plunger-like reamers are sent through the pipe lines every two days to cut paraffin from the inner surface and prevent clogging. Pumping equipment consists of five Diesels of 100 hp. and two 5-cylinder Diesels of 400 hp. Each engine operates a 17-inch pump by direct drive through a fire wall which separates them for safety because leakage is unavoidable. Engine fuel is derived from the raw crude oil as it passes through the station. About twenty-six barrels are used per day. A machine takes dirt, paraffin, and other impurities from the crude oil by centrifugation. Soft water from the roof is retained for use in the Diesels. There are three reserve storage tanks, two of 35,000 barrels capacity and one of 80,000, to take care of the variation in flow of the crude oil. In case of fire in a tank the oil is pumped out and water is forced in until there is nothing left to burn. The water flows from a deep well and is stored in a large pool made on the premises for such emergency.

In the northwest square mile of the outer section a thriving mushroom industry is located in barns at five different points. Another barn is in the south-central extreme near Seventeen Mile Road. Mushrooms are grown in darkened beds of specially prepared soil mixed with manure, straw, or other materials, and inoculated with spawn. The dirt, manure, and other ingredients are thoroughly sterilized by live steam for several days in order to prevent the invasion of species of fungi which might be poisonous or otherwise injurious to the mushroom crop. The mushroom mycelium grows abundantly under heat, moisture, and darkness until the nourishment of the soil mixture is used up. The produce is plucked each day and finds a ready market in Detroit and New York. This industry is expanding to meet an increasing demand.

Another highly specialized activity is the raising of mink. The Sherlock Mink Ranch containing over a thousand animals is about a mile west of Utica on the Auburn Road (Pl. III, Fig. 2). Mr. Sherlock has attained great skill in the crossbreeding of mink in order to develop strains of rare color and quality of fur. It takes three or more years of careful selection in breeding to obtain a new strain that will remain true to color. Jet black, silver black, patch black and white, pure white, platinum, blue platinum, and blue are some of the select colors. A few animals are worth as much as $1,000 apiece for breeding purposes when the color strain is of a rare variety. Mink are fed on a formula of ground horse meat, codliver oil, cereal, and medical ingredients. Being carnivores, they are very untrustworthy, and they bite at the least provocation. A mink bite bleeds profusely, but never becomes infected. Pelting is done in the late winter, when the fur is prime. The animals are kept in rectangular wire cages about two feet off the ground, each containing a wooden den of uniform shape placed on the upper side and adjacent to the alleyways. All manure drops to the ground through the wire bottom, and the animals keep themselves unusually clean. Mink ranching is very profitable in the hands of an expert, though it is not pleasant, since the animal has a scent gland on the order of a skunk, but the odor is less disagreeable.

Two piggeries are in the central part of the outer portion to the south of Plum Creek. The owners purchase pigs from the neighboring farmers and confine them in small enclosures, where they fatten them on garbage and grains for the Detroit market. Also typical of a suburban region are the numerous poultry houses in which chickens and turkeys are raised in large numbers for the city market. Producers enjoy the advantage of fancy prices through direct deliveries to the markets or to the consumer.

The rural influence of the outer section is best distinguished by the background and present activities within the village of Utica. This site was settled in 1817, when three families arrived by way of Canada to establish homes. Advantageously located on the Clinton River for power and transportation, the settlement grew slowly as a lumbering and distilling center. By 1880 there were 490 inhabitants, the number increased to 562 in 1900, 588 in 1920, and 1,022 in 1940. Commercial and industrial activities reflect the rural surroundings. It is estimated that about half of the laboring population finds employment in factories outside the community nearer Detroit. These people choose to remain here because of the quiet rural environment.

When the era of canal building reached the United States in the 1820's, Michigan attempted to keep pace with other states by starting the construction of a water connection between Lake St. Clair and Lake Michigan (Pl. IV, Fig. 1). It was begun in 1830, and with pick, shovel, wheelbarrow, and scraper a canal was dug from Harlow (now Utica) to Rochester. The channel was built high along the north side of the valley with a sluiceway at the upper end to control the amount of water entering it from the Clinton River. At the time of incorporation Harlow was renamed Utica after the city on the Erie Canal in New York State. Small horse-drawn barges were used to transport goods and produce from Rochester to Utica and thence by river to Mt. Clemens.

In 1846 a flour and a gristmill, now operated by the Utica Milling Company, were built at the lower end of the canal, which served as a source of waterpower (Pl. IV, Fig. 2). Huge timbers and thick planks cut from the forests of that time were joined together with wooden pegs to form the frames of these mills, which are still in good condition after more than a century of continuous operation. The mills are equipped with electric motors to meet emergencies. The chief emergencies occur when muskrats burrow through the banks of the canal, which is higher than the Clinton River, and thus cause the water to run out into the stream. Millers have been granted special permission by the State Department of Conservation to carry on out-of-season trapping of the rats so as to minimize this difficulty. About fifty barrels of Gold Lace pastry flour are manufactured per day, and it finds a ready market in Detroit and New York. The gristmill grinds large quantities of animal feed for the farmers, some of which is marketed in Detroit.

The village has an interesting monument since they have preserved one of the wildcat banks which was built in 1836. This building, having brick walls two feet thick, stands on Auburn Road just west of the Michigan Central Railroad and is used today as a dwelling. A wildcat bank had insufficient specie backing, yet issued huge amounts of paper money which it could not redeem. When a banking inspector came for the annual check up, the wildcatters would pool their specie and rush it from one to another just ahead of him so as to make the issues of paper money look legal. This bank failed as a result of the general recession which followed the Panic of 1837. Five years later its corporate rights were annulled by the Michigan legislature. Until recent years its occupants discovered in the recesses of the building bundles of the old paper money issued by the institution. This money is worthless, but makes a valuable memento of an exciting era of the past.

Utica's commercial and social life is typically rural. Farmers bring their grain to the mills and obtain their needed supplies from the commercial establishments. The tempo of this rural life has been hastened by the almost universal use of the motor vehicle for transportation. Visitors come to view the old mill, bank, canal, and printing office or to enjoy an hour in a rural village where life is still somewhat representative of an earlier period.

The growth of Detroit's northern metropolitan rim has been phenomenal since 1935. Migrants from the central city, from other parts of Michigan, and from other states have contributed the bulk of the settlers. Each of the three subdistricts of this Macomb County area represents a stage in the intensity of the urban impact of Detroit as the cultural landscape changes from rural to suburban-rural, to suburban, and, ultimately, to urban. Warren Township on the inner side of the rim shows the strong city influence and ranks third in population in the state. Many houses in the district are poorly constructed, and because of a shortage some people are forced to live in trailers. Some families get water from a common well, unsanitary outhouses are not uncommon, fire protection, sewers, and school facilities are inadequate, and street improvements lag behind the building of homes. The impact of a great industrial city has produced a growth and an expansion too rapidly for living conveniences to keep abreast of the times. These conditions are apt to continue for many years, but as the inhabitants accumulate capital, costly readjustments have to be made in order to establish a more modern American way of life.

WAYNE UNIVERSITY
DETROIT, MICHIGAN

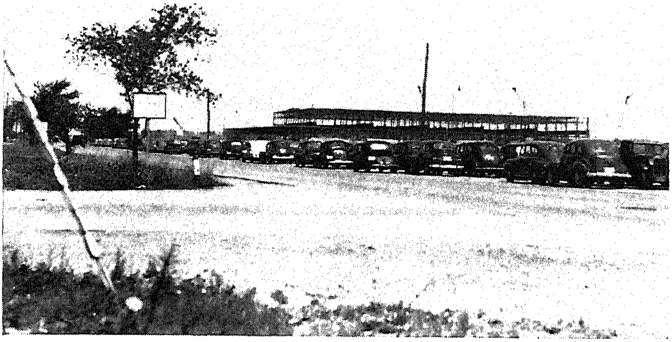

FIG. 1. Carnegie Steel Corporation Plant while under construction for the Chrysler Corporation on Mound Road

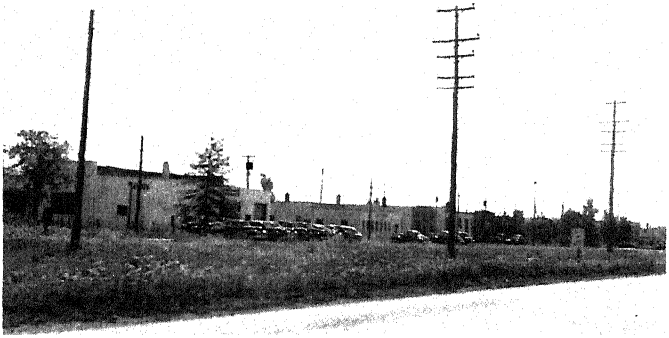

FIG. 2. Symbiotic light industries on Mound Road near Nine Mile Road

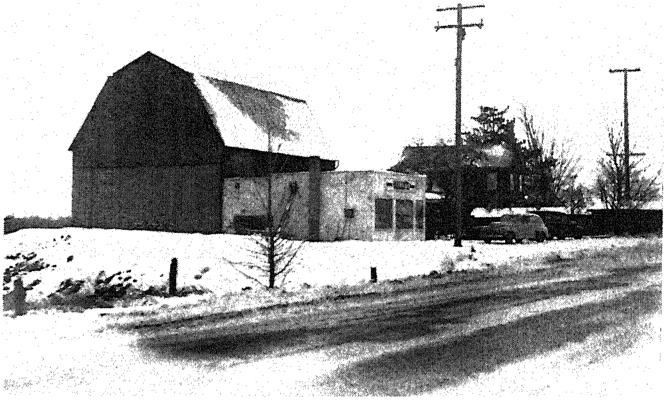

FIG. 1. An old farmstead barn converted into a store and shop dealing in building supplies

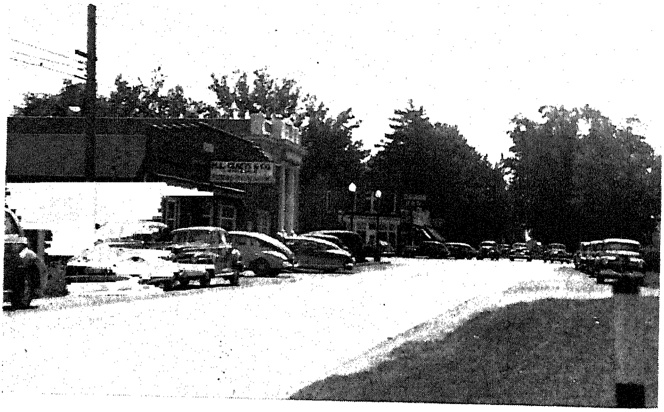

FIG. 2. Warren Village, on Mound Road at Chicago Road, experiencing a little of the urban impact

FIG. 1. Dairy cattle grazing on the lush pastures of the outer portion of the district near Utica

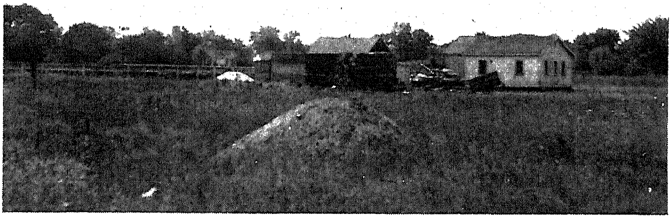

FIG. 2. Sherlock Mink Ranch, containing about one thousand animals of high-quality fur and in rare color strains, located on Auburn Road to the west of Utica

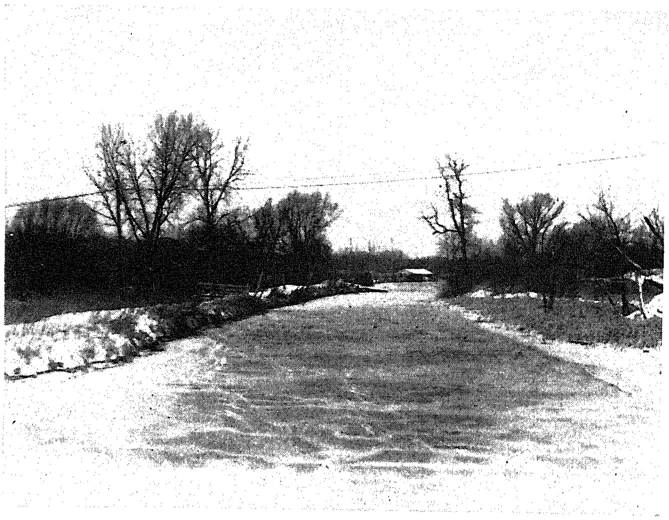

FIG. 1. The old Utica-Rochester ship canal, constructed by hand and team labor in 1830, now supplying water power to the Utica Milling Company

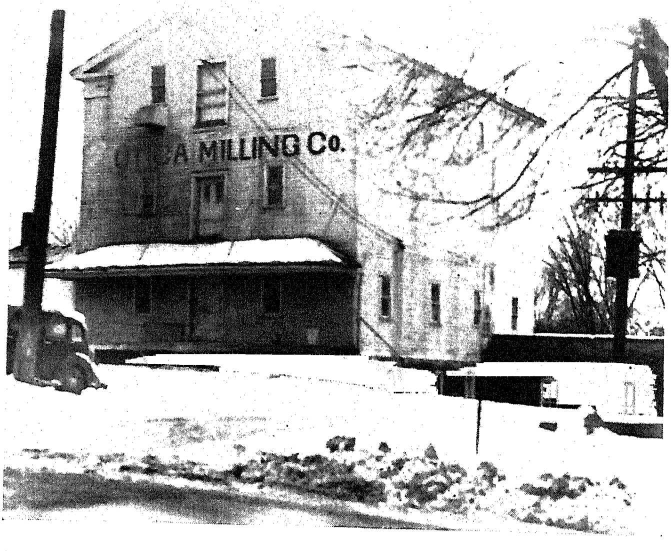

FIG. 2. Utica Milling Company flour mill constructed in 1846 of heavy pegged plank and timber from the forests of that day; it rolled the wheat from the rural community into Gold Lace pastry flour at the rate of fifty barrels a day

A SURVEY OF LAND USE AND LAND OWNERSHIP ON BOIS BLANC ISLAND

BURKE VANDERHILL

INTRODUCTION

IN THE extreme northwestern portion of Lake Huron, between the upper and the lower peninsulas of Michigan, lie a number of islands which have been significant in varying degrees to the Indian, French, British, and American occupants of this region. The largest of these is Bois Blanc[1] Island, which is at the eastern entrance to the Straits of Mackinac (Fig. 1).

Despite its size, the island has played a minor rôle in the affairs of the Straits of Mackinac region. For the Indians it was primarily a source of maple sugar, and only an occasional camping place. Since the coming of the white man it has been overshadowed by Mackinac Island, a much smaller island less than three miles to the northwest, which it long served as an auxiliary supply base. Having experienced a short boom period of lumbering and land speculation, the island today is a quiet summer resort area, with a few clusters of cottages along its southern and eastern shores. It remains an outpost, which travelers by-pass and is little known outside the immediate vicinity.

It is the purpose of this study to evaluate Bois Blanc Island in terms of its utility to the various peoples who have occupied the Straits region.

PHYSICAL CHARACTERISTICS

Roughly pear-shaped, Bois Blanc Island is twelve miles long and has a maximum width of six miles, and thus comprises an area of about thirty-four square miles. Viewed from the mainland, the island appears low and featureless, for its elevation seldom exceeds fifty feet above the level of Lake Huron.[2] Upon closer examination, however, surface irregularities become apparent.

[1] Most commonly pronounced "Bob-lo."

[2] No point exceeds one hundred feet above lake level.

Trending roughly parallel to the longer axis of the island is a succession of irregular north-facing cliffs or scarps which range between ten and thirty feet in height above their bases. These scarps, carved in dolo-

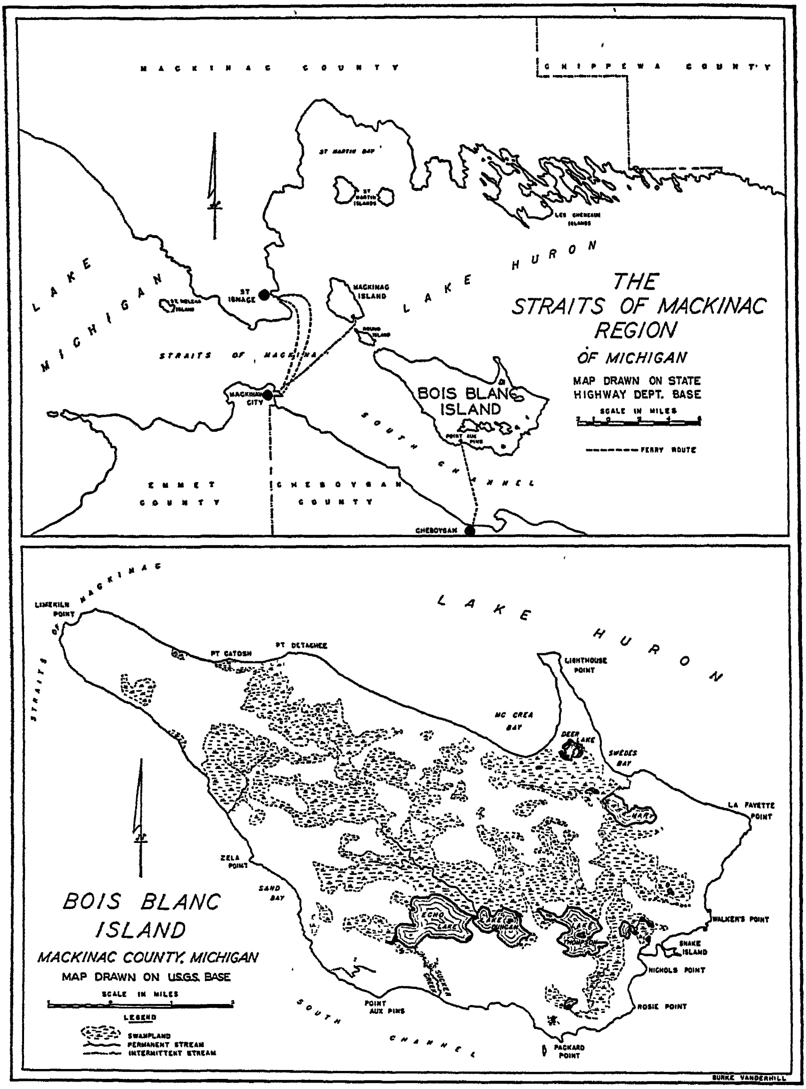

FIGURE 1

mitic rocks whose strata dip gently southward, are evidence of the cuesta-form nature of the island. Most of the surface consists of a series of nearly level benchlands which extend southward from the crest of each scarp to the base of the next. They vary in width from a few hundred feet to over a mile, and have many low, gravelly ridges meandering across their surfaces. The benchlands are composed of unconsolidated glacial till deposited by the continental ice masses of the Pleistocene. This material was reworked by wave action during the successive lake stages which followed the withdrawal of the glacier, and thus was produced a complex of lake benches and beach ridges.

The present shorelines of the island resemble their predecessors in being predominantly gravelly or stony. There are, however, a number of coves along the southern and eastern shores which have sandy beaches. The water is shallow for some distance offshore, and no natural harbor exists.

The drainage pattern on Bois Blanc Island is an irregular one (Fig. 1). In the southeastern two thirds of the island there are about a dozen shallow lakes and several extensive areas of swamp, which, in view of the dip of the bedrock and the porosity of the till overlying it, seem to be maintained by underdrainage from the north and northwest. Only two permanent streams are found. One arises in the central part and flows southeastward into Lake Duncan. Since Lake Duncan and Echo Lake are joined, the second stream, Sucker Creek, which connects Echo Lake with Lake Huron, is really a continuation of the first. A few short creeks, intermittent in flow, are found along the southern and eastern shores.

Bois Blanc Island lies in a region of long, cold winters and short, mild summers, in which precipitation is well distributed throughout the year.[3] The winds of winter sweep across the ice-covered expanses of the lake without hindrance, frequently causing sensible temperatures to be bitterly cold. In summer the encircling waters usually keep temperatures comfortably mild.

The island's podzolic soils are well supplied with lime and are, therefore, inherently rather fertile, but their coarse texture and high content of stone and gravel make them generally unsuited to agriculture. Swamp soils, largely acid mucks and peats, comprise nearly one quarter of the

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[3] This is the Dfb climate of the Koeppen system. The January mean temperature is 18° F., the July mean temperature is 65° F., and the mean annual precipitation is twenty-seven inches. Data were secured by interpolation from those of nearby stations.

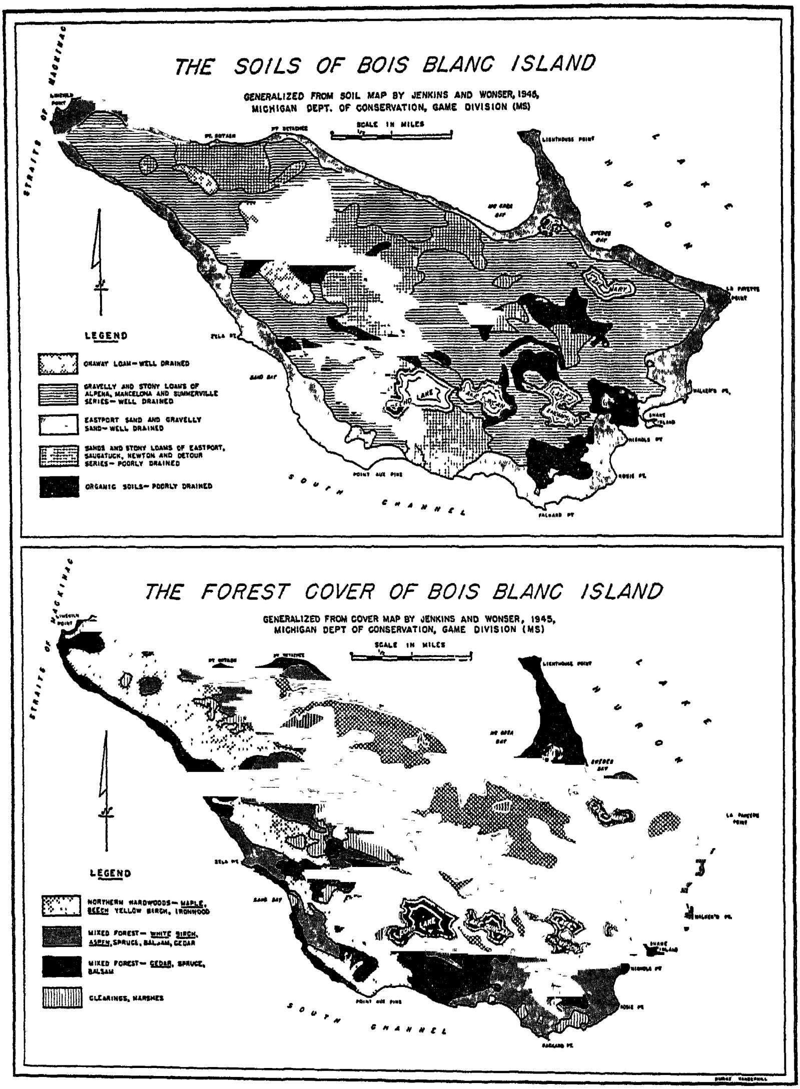
THE SOILS OF BOIS BLANC ISLAND
GENERALIZED FROM SOIL MAP BY JENKINS AND WONSER, 1946, MICHIGAN DEPT. OF CONSERVATION, GAME DIVISION (MS)
SCALE IN MILES
½
1
LEGEND
ONAWAY LOAM—WELL DRAINED
GRAVELLY AND STONY LOAMS OF ALPENA, MANCELONA AND SUMMERVILLE SERIES—WELL DRAINED
EASTPORT SAND AND GRAVELLY SAND—WELL DRAINED
SANDS AND STONY LOAMS OF EASTPORT, SAUGATUCK, NEWTON AND DETOUR SERIES—POORLY DRAINED
ORGANIC SOILS—POORLY DRAINED
STRAITS OF MACKINAC
LAKE HURON
SOUTH CHANNEL
LIGHTHOUSE POINT
LA FAYETTE POINT
WALKER'S PT.
SNAKE ISLAND
NICHOLS PT
PACKARD PT
POINT AUX PINS
SAND BAY
LAKE
THE FOREST COVER OF BOIS BLANC ISLAND
GENERALIZED FROM COVER MAP BY JENKINS AND WONSER, 1945, MICHIGAN DEPT OF CONSERVATION, GAME DIVISION (MS)
SCALE IN MILES
LEGEND
NORTHERN HARDWOODS—MAPLE, BEECH YELLOW BIRCH, IRONWOOD
MIXED FOREST—WHITE BIRCH, ASPEN, SPRUCE, BALSAM, CEDAR
MIXED FOREST—CEDAR, SPRUCE, BALSAM
CLEARINGS, MARSHES
STRAITS OF MACKINAC
LAKE HURON
SOUTH CHANNEL
LIGHTHOUSE POINT
LA FAYETTE POINT
POINT AUX PINS
SAND BAY
PACKARD PT.

FIGURE 2

total. Only a few scattered patches of good agricultural soil are found,[4] principally in the western portions of the island (Fig. 2).

Bois Blanc Island was originally densely forested. A mixed growth of white and yellow birch, sugar maple, hemlock, and various conifers occupied the well-drained lands, while cedar occurred on the swampy lands.[5] The island today is 95 per cent wooded, but the composition of the forest has changed. Except for the mature timber on Lighthouse Point, long held by the Government, the forest is second growth and is coming back in thick stands (Fig. 2). Northern hardwoods occupy about 23 per cent of the area of the island,[6] occurring most commonly on the heavier well-drained soils. The species represented include sugar maple, beech, yellow birch, and ironwood. The remainder of the forest consists of admixtures of hardwoods and softwoods in varying proportions. On light, generally well-drained soils white birch and aspen predominate, associated with spruce, balsam, and cedar. This type covers about 38 per cent of the total area. A mixed forest in which spruce, balsam, and cedar are dominant covers the remaining 25 per cent of the island, mostly poorly drained. Solid stands of cedar, formerly widespread on such lands, now occur only in a few small patches near some of the inland lakes. Most of the second-growth timber ranges between six and nine inches in diameter, although some areas have older stands which are already merchantable.

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[4] Onaway loam.

Wildlife is fairly plentiful on the island, but is limited in variety. Deer, snowshoe rabbits, beaver, and duck are the principal game species, though individuals of others are occasionally reported. Fish are found in the larger inland lakes, but apparently not in abundance, and the shore waters are not well stocked. Owing to the large areas of swampland, insect life is abundant on the island, and during the early summer mosquitoes, black flies,[7] and "no-seeums"[8] are particularly numerous and annoying.

In summary, the basic resources of Bois Blanc Island seem to be its timber, the dolomitic rock available at the surface, its wildlife population, a mild summer climate and some stretches of sandy beach — resources in which, however, it is equaled or surpassed by much of northern Michigan. On the other hand, its poor soils, large areas of swamp and the seasonal swarms of insects associated with them, and the lack of harbors and fishing grounds would seem to be major disadvantages.

[5] Data were secured from field notes of the General Land Office survey of 1827.

[6] These percentages were estimated on the basis of "Report 908" (unpublished) of the Game Division, Michigan Department of Conservation, prepared by B. C. Jenkins and C. H. Wonser, 1946.

[7] Genus *Simulium*.

[8] Genus *Ceratopogon*.

Let us see how man has made use of the island through the various periods in its history.

EARLY HISTORY AND SIGNIFICANCE

While the Straits of Mackinac region was comparatively well populated before the coming of the white man, there is no evidence that permanent camps or villages ever existed on Bois Blanc Island.[9] The Indians of the region chose to establish their villages on Mackinac Island, Round Island, St. Martin's Islands, or on the neighboring mainlands (Fig. 1), which were adjacent to their principal fishing grounds and which had better soil for growing corn.[10] The Straits formed a constriction in both the land and the water routes followed by the Indians, but Bois Blanc Island lay several miles east of the junction, and was usually by-passed. Their principal interest in the island was in its groves of sugar maple, the finest in the region, and they came here across the ice, in late February or early March, to make maple sugar. They called the big island Mi-ko-bi-min-iss — "White Wood Island" — because paper birch and aspen were common along its shores.[11]

The French missionaries and fur traders, in the course of westward expansion from the St. Lawrence Valley, came into the Straits region in the late seventeenth century. Since their interests were in converting the Indians as well as in trading with them, they established themselves in or near the Indian villages of the region.[12] The French at various times had forts on Mackinac Island and the northern and southern mainlands, in each case taking advantage of defensible positions and harbors located on the main routes of travel. The big island, whose name they translated into French as Île aux Bois Blanc, served them, as it did the Indians, as a source of maple sugar.[13] Because of the proximity of its western end to Mackinac Island, the settlers began to come to Bois Blanc Island to cut wood, walking over the ice in the winter, and later they established here a few scattered plantings of apple trees.[14] Some woodcutters' huts were erected on the island, but there seems to have been no permanent settlement.

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[9] Hinsdale, Wilbert B., *Archeological Atlas of Michigan* (Michigan Handbook Series, No. 4, Ann Arbor, University of Michigan Press, 1931), p. 27.

[10] Van Fleet, Rev. James A., *Old and New Mackinaw* (Ann Arbor, Courier Steam Press, 1870), p. 8.

[11] Davis, Marion M., "Three Islands," *Michigan History Magazine,* 12 (1928): 513.

[12] Father Marquette arrived at Mackinac Island in 1670 and built a mission there the following year. Van Fleet, *op. cit.,* p. 6.

[13] Maple sugar was a prized item in the days when cane sugar was difficult or impossible to secure.

The British, having wrested Canada from the French in the middle of the eighteenth century,[15] came into the Straits region not as settlers but as soldiers and merchants, and after preliminary surveys they chose Mackinac Island as the site of their fort and fur posts because of its defensible heights, its excellent harbor, and its strategic location.[16] Bois Blanc Island had little significance to them except as a source of firewood for their garrison and their warships.

The island came into American hands in 1795 as the direct gift of the Chippewa nation, at about the time Mackinac Island was relinquished by the British,[17] and under early American control it remained a supply base for Mackinac Island. The army constructed a kiln at the western end of Bois Blanc Island (Fig. 3), in which dolomite was burned to secure lime for use in Fort Michilimackinac, and also utilized the island as a fuel reserve for the fort.[18] Some small gardens were established near the south shore (see Missionaries' Wharf, Fig. 3) by the Presbyterian Mission at Mackinac Island to satisfy their needs for vegetables and at the same time to train the older Indian boys in methods of cultivation.[19] With the closing of the mission in 1825 the gardens were abandoned.

Residence on Bois Blanc Island was sporadic or, at best, seasonal, and was generally restricted to the well-drained western and northwestern margins, facing Mackinac Island. The first landholding on the island for which a record exists was the private claim of Michael Dousman, approximately 640 acres on Limekiln Point (Fig. 3), which was privately surveyed in 1810. Dousman was a leading businessman of Mackinac Island and also owned timber property and sawmills on the mainland adjacent to Limekiln Point. By the time of the General Land Office survey of Bois Blanc Island in 1827 he had cut timber from much of the northern part of his claim, shipping it to his mainland mills from Missionaries' Wharf.[20]

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[14] Most of these French settlers were from northern France, where apples were commonly grown, and they continued the Old World practice here.

[15] The British defeated the French in the battle of Quebec in 1759. They took actual possession of the Straits region in 1761. Van Fleet, *op. cit.*, p. 31.

[16] "In the report of the British Governor, Major Sinclair, in 1779, the superiority of Mackinac Island as a strong position against Indian attacks . . . was pointed out; also its advantage as having one of the best harbors in the upper country, and as respects the fishing interests likewise." Meade C. Williams, *Early Mackinac, A Sketch,* Third Edition (St. Louis, Mo.: Buschart Bros., 1901), pp. 34–35.

[17] Mackinac Island was ceded to the United States under the terms of the Treaty of Paris, 1783, and transfer was implemented by the Treaty of Amity, Commerce and Navigation, 1795. The approval of the Indian tribes for this transfer was secured by General Anthony Wayne in the Treaty of Greenville, 1795.

[18] Lawler, W. F., "Michigan Islands," *Michigan History Magazine,* 22 (1938): 296.

[19] Davis, *op. cit.*, p. 514.

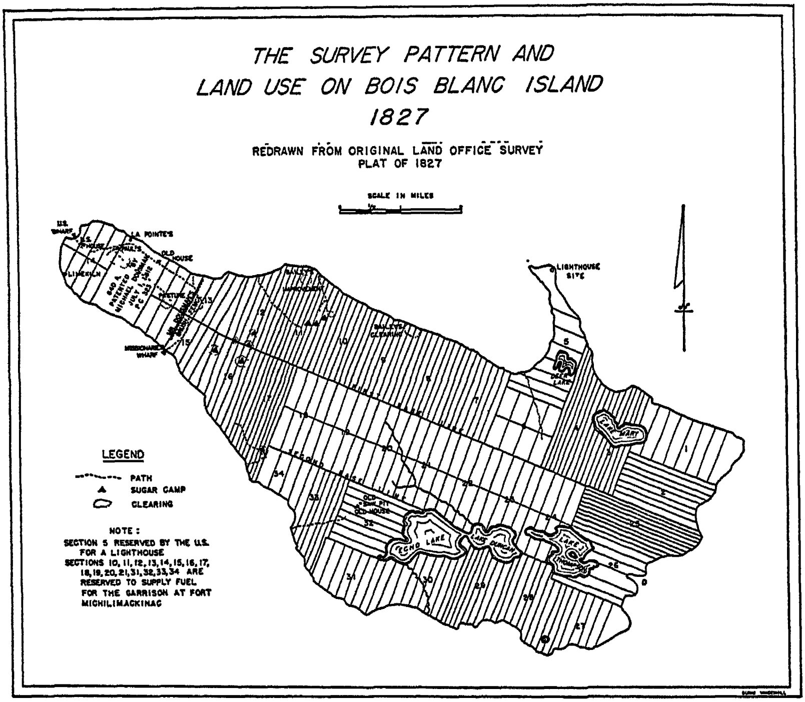
THE SURVEY PATTERN AND LAND USE ON BOIS BLANC ISLAND 1827
REDRAWN FROM ORIGINAL LAND OFFICE SURVEY PLAT OF 1827
SCALE IN MILES
U.S. WHARF
U.S. HOUSE
LA POINTE'S
OLD HOUSE
LIMEKILN
640 A. PATENTED BY MICHAEL DOUSMAN JULY 1, 1812 P.C. 323
PASTURE
MISSIONARIES' WHARF
LIGHTHOUSE SITE
DEER LAKE
LAKE MARY
ECHO LAKE
LAKE DUNCAN
LAKE THOMPSON
OLD SAW PIT
OLD HOUSE
LEGEND
PATH
SUGAR CAMP
CLEARING
NOTE :
SECTION 5 RESERVED BY THE U.S. FOR A LIGHTHOUSE
SECTIONS 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 31, 32, 33, 34 ARE RESERVED TO SUPPLY FUEL FOR THE GARRISON AT FORT MICHILIMACKINAC

FIGURE 3

Although there is evidence that he grazed cattle on the island at one time, apparently he was not doing so at the time of the survey. The survey recorded two occupied dwellings and several clearings along the northern shore and, in addition, there were on the island at this time a house belonging to the Government, two abandoned dwellings, and a number of sugar camps (Fig. 3).

Because of its shape and the fact that its area approximated that of a township, Bois Blanc Island was surveyed in an unusual manner (Fig.

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[20] This information was included in the field notes of the survey.

3). Two base lines were laid off parallel to the longer axis, and from them, 34 odd-shaped sections were surveyed, each comprising as close to 640 acres as possible. Then, since the usual land descriptions would not apply here, each section was subdivided into Government lots of approximately 80 acres, surveyed in such a way that 80 per cent of them were given water frontage. Dousman's claim was acknowledged and was not incorporated into the survey grid. As soon as the survey plat was recorded, the Government withdrew from entry 16 sections in the western half of the island as a fuel reservation for Fort Michilimackinac, and set aside section 5 as a reserve for a proposed lighthouse (Fig. 3).

THE PERIOD OF REORIENTATION

In the years following the survey the lighthouse was built, and the land open to entry passed gradually into private hands. There were desultory attempts to settle on the island and to farm its rocky soil, but most owners were interested only in the timber on their lands. Cutting on a small scale was carried on, mainly for firewood, poles, posts, and shingles.

Since most of the western half of the island was a Government reservation, land acquisition was largely in the southeastern portion, by people from the mainland rather than from Mackinac Island. Thus Bois Blanc Island began to face southward, toward Cheboygan, instead of northwestward, as it had done for so many years.

THE BOOM ERA OF LUMBERING AND LAND SPECULATION

The withdrawal of the Mackinac Island garrison in 1895 and the relinquishment of its fuel reservations on Blois Blanc Island coincided with the peak of lumbering activities on the neighboring mainland, and the lumber interests began to acquire land on the island in the hope of extending their operations for a few years. Landholdings were consolidated as well as possible by three companies, sometimes by the leasing of timber rights, sometimes by outright purchase (Fig. 4).

Lumbering operations on the island began at about the turn of the century. A steam sawmill to handle hardwood logs was erected at Sand Bay by the largest company, and a railroad was built into the interior to bring the logs to the mill. The other timber operators seem to have transported their logs to Cheboygan for milling. Cutting proceeded rapidly, and by 1908 most of the merchantable timber had been exhausted.[21]

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[21] Except for that in section 5, still held as a lighthouse reserve by the Government, and the timber in scattered private holdings.

The mill was dismantled, the railroad was torn up, and only the scars of lumbering remained.

In 1898 an organization known as the "Bois Blanc Island Land Company" purchased two Government lots in sections 30 and 31, and by 1900 a hotel and nine cottages had been built at Point Aux Pins. By 1905 several more cottages had been built nearby along the Lake Huron shore (Fig. 4). Thus the first evidences of the present pattern of land use began to emerge.

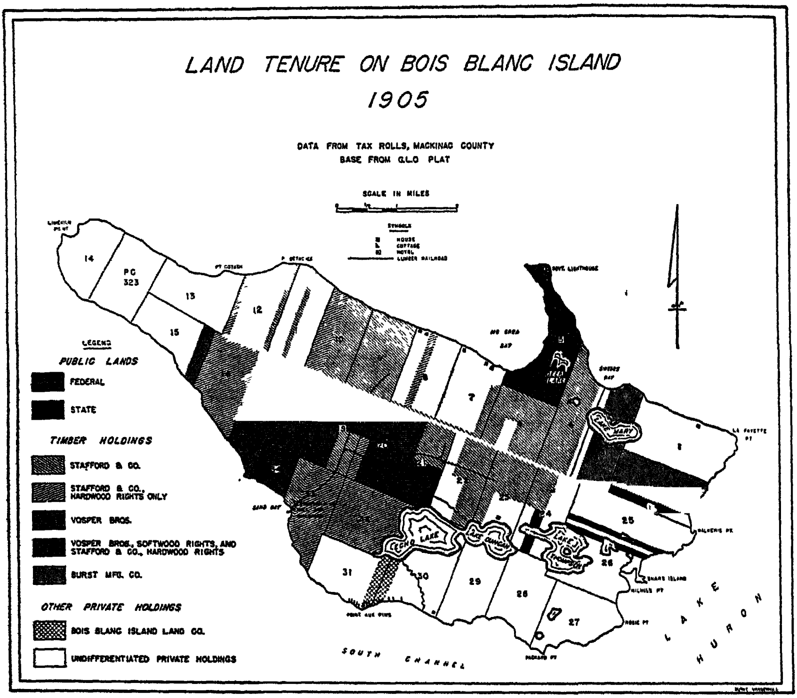

FIGURE 4

After the fire which swept over the island in 1908 in the wake of lumbering, destroying some of the cottages, the land company was bought out by a group of Detroit people who were incorporated as the "Point Aux Pins Association," and their shore holdings were platted as the first resort subdivision on the island. Interest in resort property here grew, especially among Detroiters, and nine more subdivisions were established

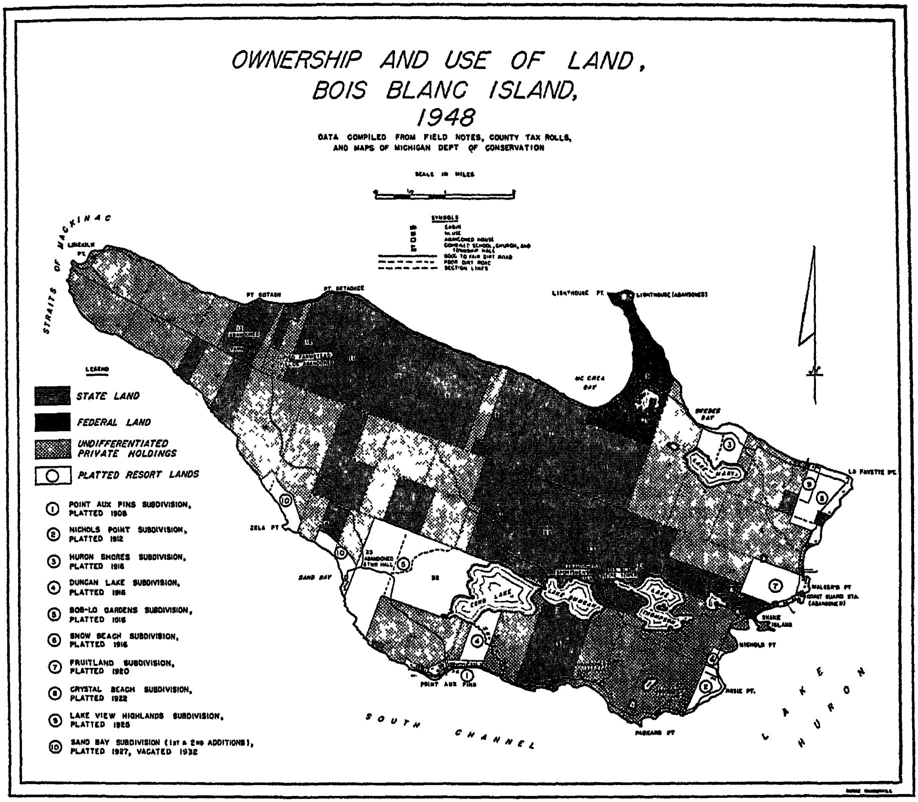
OWNERSHIP AND USE OF LAND,
BOIS BLANC ISLAND,
1948
DATA COMPILED FROM FIELD NOTES, COUNTY TAX ROLLS, AND MAPS OF MICHIGAN DEPT OF CONSERVATION
SCALE IN MILES
0
1/2
1
SYMBOLS
CABIN
IN USE
ABANDONED HOUSE
COMBINED SCHOOL, CHURCH, AND TOWNSHIP HALL
GOOD TO FAIR DIRT ROAD
POOR DIRT ROAD
SECTION LINES
LEGEND
STATE LAND
FEDERAL LAND
UNDIFFERENTIATED PRIVATE HOLDINGS
PLATTED RESORT LANDS
① POINT AUX PINS SUBDIVISION, PLATTED 1908
② NICHOLS POINT SUBDIVISION, PLATTED 1912
③ HURON SHORES SUBDIVISION, PLATTED 1916
④ DUNCAN LAKE SUBDIVISION, PLATTED 1916
⑤ BOB-LO GARDENS SUBDIVISION, PLATTED 1916
⑥ SNOW BEACH SUBDIVISION, PLATTED 1916
⑦ FRUITLAND SUBDIVISION, PLATTED 1920
⑧ CRYSTAL BEACH SUBDIVISION, PLATTED 1922
⑨ LAKE VIEW HIGHLANDS SUBDIVISION, PLATTED 1925
⑩ SAND BAY SUBDIVISION (1ST & 2ND ADDITIONS), PLATTED 1927, VACATED 1932
STRAITS OF MACKINAC
LINCOLN PT
PT GOTASH
PT. DETACHEE
LIGHTHOUSE PT.
LIGHTHOUSE (ABANDONED)
MC CREA BAY
SWEDES BAY
LAKE MARY
LA FAYETTE PT.
WALKER'S PT
COAST GUARD STA. (ABANDONED)
SNAKE ISLAND
NICHOLS PT
ROSIE PT.
PACKARD PT
LAKE HURON
ZELA PT
SAND BAY
ABANDONED TWP HALL
LONG LAKE
LAKE DUNCAN
LAKE THOMPSON
POINT AUX PINS
SOUTH CHANNEL

FIGURE 5

in succeeding years, primarily as speculative ventures (Fig. 5). By 1927 most of the property that could be acquired along the southeastern and eastern shores was platted.

The plats were drawn on the basis of the Government survey grid with little regard for surface features. As a result, many of the interior lots were swampy, and in one area several were actually under the waters of Echo Lake. A total of 11,000 lots were platted on the island. Promotional schemes were successful in disposing of most lots sight unseen, both to local people and to outsiders. It is estimated that four to five thousand were eventually sold, though only about three thousand deeds were actually recorded.

Though most of the lots were held by their owners as investments, about a hundred cottages were constructed, mainly along the shore. A sportsmen's club was established northeast of Lake Duncan, and ambitious plans were made to build an airplane landing field on the benchlands east of Lake Mary. Deer hunters were beginning to come to the island in increasing numbers.

Several families settled along the shore near Point Aux Pins, and served as caretakers for the cottages. At least two attempts at farming were made on small patches of fairly good soil in the western part of the island, and two apple orchards were established near Packard Point, one a twenty-acre commercial orchard. A Coast Guard station was placed at Walker's Point, and a small post office and a summer church were built at Point Aux Pins. Meanwhile the cutover lands of the interior were still in the hands of the lumber companies, lying idle, in the hope that they could be disposed of profitably. Gradual reforestation by volunteer growth led to the establishment of a fire tower on a ridge near Lake Thompson, and during very dry periods a towerman was in residence. The island's prospects looked good, and then came the crash of 1929.

THE PERIOD OF RETRENCHMENT AND READJUSTMENT

The depression caused a rapid collapse in the promotional bubble on Bois Blanc Island. Sand Bay subdivision, the last to be platted, had disposed of only a few lots by this time, and was vacated in 1932. After the tax moratorium of the lean years tax delinquency mounted rapidly, and soon land began to revert to the state. While most of the better shore lots remained in private hands, and some of those in the interior were retained by local owners as woodlots, a large proportion of the interior platted lands and the former timber holdings eventually were allowed to revert, and the sportsmen's club was abandoned (Fig. 5).

The abandonment of permanent residences was not as rapid. During the depression years there was a measure of security on the land, where at least a subsistence economy was possible. It was during the more prosperous years that followed, therefore, that the permanent residents began to leave the island. The commercial orchard was among the first to succumb (see Pl. I, Figs. 1–2), owing to a combination of low commodity prices, the inability to compete with mainland producers with better transportation facilities, and, it is said, poor management practices. Farming was eventually abandoned entirely, and some of the residents of Point Aux Pins also left the island.

The depression years caused an increase in hunting out of season, and sometimes the illegal use of dogs in hunting deer, on the part of both the islanders and the mainlanders. The reduction of the deer herd to near extinction, coupled with the increasing acreages of land in state ownership, led to the appointment, in 1936, of a resident conservation officer and towerman. Under protection the deer population increased rapidly, and each year more hunters came to the island, at first mainly from the nearby mainland, later predominantly from downstate areas.[22]

With the general return of prosperity there was no new resort boom on the island, but additional summer cottages were built from time to time. An attempt was made to establish a girls' wilderness camp on Lighthouse Point, the lighthouse having been abandoned for some time, but this was not successful, possibly because of the difficulty of access. In this period of readjustment the dominantly recreational function of the island was accentuated.

THE PRESENT PATTERN

Bois Blanc Island today is essentially a quiet summer colony for those who enjoy comparative isolation during their vacation months. About 120 cottages are located along the tree-lined southern and eastern shores, with concentrations at Point Aux Pins and Walker's Point (Pl. I, Fig. 3; Pl. II, Fig. 1). In addition, there are a few cabins on Limekiln Point (Fig. 5). Permanent residence is limited to seven or eight families, most of whom live in Point Aux Pins, the only settlement on the island. Some serve as caretakers around the cottages, and occasionally accept employment on the mainland during the winter, while a few are living in retirement. There is one occupied farmstead, but the land is no longer farmed. No agriculture exists on the island at the present time.

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[22] Information secured from "Report 891" (unpublished), Game Division, Michigan Department of Conservation, by I. H. Bartlett, 1945.

The only service establishments on the island are in Point Aux Pins; they consist of a small summer hotel, a post office, and a summer church which doubles as the township school in winter and also serves as the township hall. There are no stores, and supplies must be brought in from Cheboygan. A mailboat service is operated by an island family (Pl. II, Fig. 2), the schedule varying with the needs of the season. During the winter months, when South Channel is frozen over, mail and supplies are brought over the ice by truck or automobile, and in the periods when the ice is unsafe an airplane is chartered to maintain the connections.[23]

Bois Blanc Island is a part of Mackinac County,[24] whose county seat is St. Ignace, on the Upper Peninsula mainland. Since all communication is with Cheboygan, the county has not maintained the roads on the island, and they are little more than trails through the forest. The widespread occurrence of gravel at the surface has provided a substantial base for these roads, however, and has made it possible to improve, to some extent, the shore road from Point Aux Pins to Walker's Point (Pl. III, Figs. 1–2). The typical mode of conveyance, among islanders and resorters alike, is an ancient automobile or truck, operated without the formality of license plates.

The island has not experienced a postwar building boom as have many northern Michigan resort areas, and in 1948 only six cottages were under construction. There has been some effort to sell lots in the subdivisions at La Fayette Point, but the poor service and transportation facilities have discouraged sales.

About 10,000 acres, or nearly 50 per cent of the island, are now state-owned, and the reversion of tax-delinquent lands, especially in the interior, is continuing. These lands are administered as a part of Black Lake State Forest, most of which lies on the mainland to the south. About 700 acres are still in Government ownership, and they include the lighthouse reserve, section 5, and the buildings and grounds of the Coast Guard station, recently abandoned.

Hunting is increasing, although its main benefits are felt in Cheboygan rather than on the island itself. The deer herd is estimated to contain nearly 300 animals and is growing, but it may soon reach the limit of its browse, for the second-growth forest is increasing in density, and the clearings are being reclaimed by aspen and fire cherry.

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[23] There is a telephone cable connecting Point Aux Pins with Cheboygan.

[24] In 1818 most of northern Michigan Territory was placed in newly organized Mackinac County, with the county seat then at Mackinac Island. Bois Blanc Island has remained within that county, in spite of its present ties with Cheboygan.

In general, the second-growth timber is not yet being used, although mainlanders continue to cut firewood on their land during winter months, when it can be hauled across the ice. Some of the older second growth on the western end of the island has reached merchantable size, however, and in 1948 a Petoskey interest purchased 160 acres of timberland at the base of Limekiln Point, estimated to contain 600,000 board feet of hardwood. Lumbering was begun on the contract basis, and 350,000 board feet of logs were brought to the beach on the south side of the point. There they lie today. The cost of transporting them from the island to the mainland was so high that the terms of the contract could not be met, and logging came to a halt. The land and logs are now for sale. The recreational function of the island remains dominant.

CONCLUSIONS

Man has been attracted to Bois Blanc Island for many reasons, but throughout the fabric of its history one thread has been discernible — his primary purpose has been to take something *from* the island. Sugar, fuel, lime, timber, and game have all served to bring him here, and in each case his stay was brief. This is understandable, for there was no good reason to tarry. None of these resources alone or in combination would have been sufficient to support a permanent settlement. Cheap land also has drawn man to the island from time to time, but each attempt to farm the stony soil has been abortive.

Only within the last sixty years has the principal resource of the island, the recreational one, been developed. It has been developed slowly, by trial and error, and has survived fire, speculation, and depression. The disadvantages of the site and situation of the island have been selective factors in the growth of the resort colony, for its members have come here expressly for the quiet privacy that isolation affords.

A further gradual increase in the number of cottages seems probable, for there are a number of sandy beaches as yet undeveloped (Pl. II, Fig. 3), and there are possible cottage sites on the low bluffs along the northern and northwestern shorelines. In the interior, where insects are bothersome, it seems likely that property will continue to revert to state ownership to be administered as hunting land and potential timberland. By-passed by the multitudes, the island will continue to perform a useful service for the few.

UNIVERSITY OF MICHIGAN

PLATES I–III

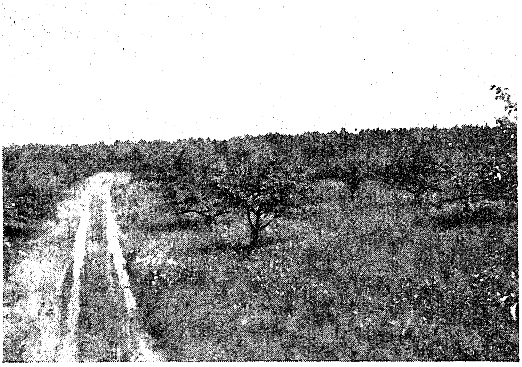

FIG. 1. A portion of the abandoned orchard near Packard Point; looking northwest

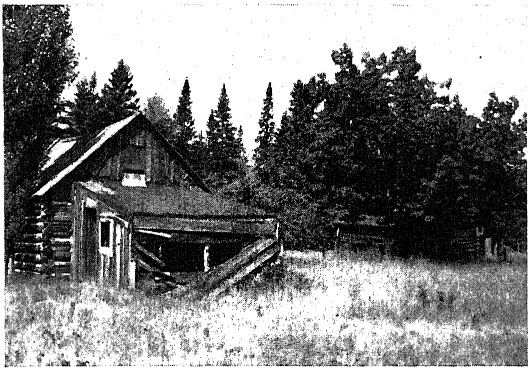

FIG. 2. The abandoned farmstead connected with the orchard

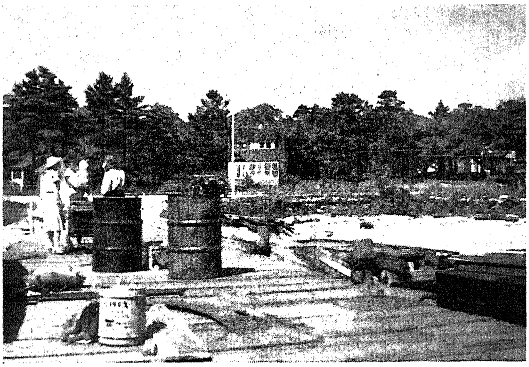

FIG. 3. Point Aux Pins, looking north from the dock. The vehicle is typical

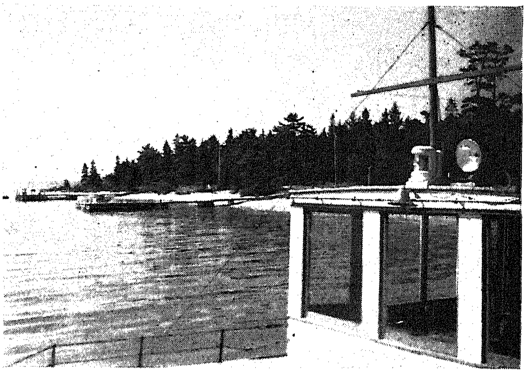

FIG. 1. Point Aux Pins, looking west from the dock. The cottages are hidden in the trees. Conifers predominate in the shoreline complex

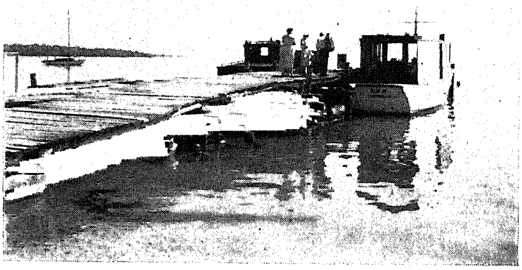

FIG. 2. The dock and the mailboat at Point Aux Pins; looking southeast

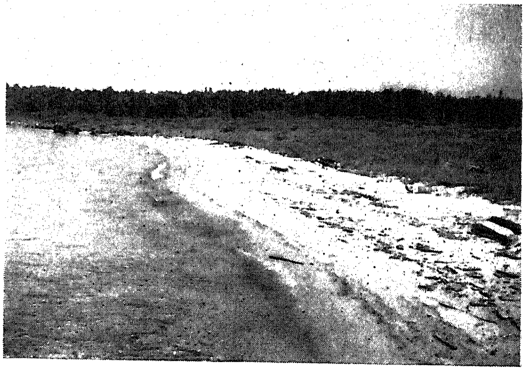

FIG. 3. Former sawmill site at Sand Bay, one of several stretches of beach as yet undeveloped. The island's low silhouette is evident in the background

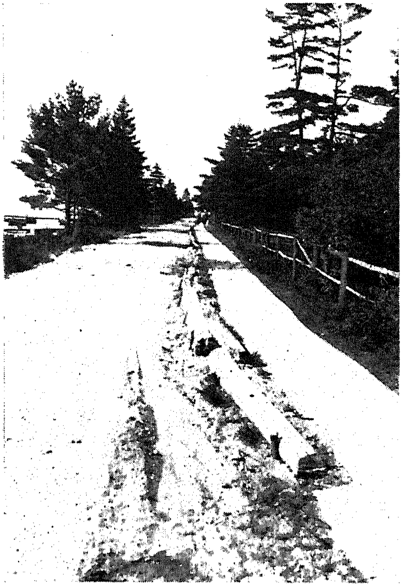

FIG. 1

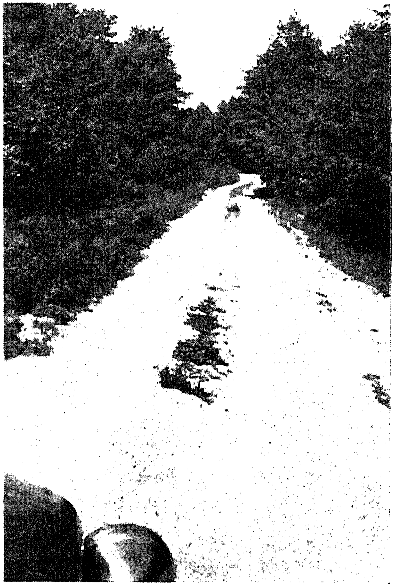

FIG. 2

FIG. 1. The shore road at Point Aux Pins; looking west. This is the best road on the island

FIG. 2. A better part of the road between Point Aux Pins and Limekiln Point. The second-growth timber on this well-drained land is hardwood

GEOLOGY

GRAVITATIONAL DISTORTION AND FISSION

HOWARD B. BAKER

THE EARTH AS A PART OF THE SOLAR SYSTEM

CONCERNING the past of this earth there is a self-evident truth that geologists will do well never to forget or ignore. The earth is one member of an isolated mechanical cluster of bodies, the solar system. It has participated in the evolution of that system and the story of that participation must of necessity be included in the geologic record.

The present study has resulted from the application of methods developed some forty years ago. Large-scale continental movements in the earth's past have been investigated by the aid of a globe with movable continents. Such a globe was first demonstrated before the geologic section of this academy in 1911. There are several forms of the device, the simplest and also the best being easily made by anyone who is interested. The globe is greased to prevent the parts from sticking together, and tissue paper for tracings is applied to it with gelatin dissolved in water. After drying, tracings are made, lifted off, and trimmed. The results obtained by the use of such globes have been tested and amply verified by all sorts of collateral evidence afforded by stratigraphy, tectonics, petrology, mechanics, geographical distribution of plants and animals, and even by astronomy and other sciences. Fascinating as the details are, they cannot at this moment be adequately reviewed. It is time, rather, for us to summarize, taking the whole subject in one comprehensive view, realizing what it is that we are talking about, looking at big mechanical effects in a big mechanical way.

OBVERSE AND REVERSE OF THE GLOBE

Although the earth is a spheroid, it, like a medal, has an obverse and a reverse side. These opposite sides present contrasting sets of surface features. The Pacific hemisphere is here regarded as the *obverse* (Fig. 1). There has been convergent movement of crustal fragments, a great pulling from every direction toward a focus in the Australian region. The travel has been greatest in the most forward fragments and less and less in those farther back. This alone is conclusive evidence that the cause was a gravitational attraction outside the earth and not a forward pushing or propulsion from the rear.

The *reverse* of the spheroid is the opposite hemisphere, the Atlantic (Fig. 2). Here, extending almost from pole to pole, is a widened crack or rift, a vast parting line on the two sides of which the fragments moved away, each and every one on a great circle path toward the Pacific focus. Here again are seen the effects of extraterrestrial gravitation, lagging of the rearmost fragments, and the progressive forward hastening of the more advanced. Here is also seen a progressive widening of the Atlantic rift toward the south, which clearly means that the tractive causal force was more effective in the southern part of the Pacific side.

ASTRONOMICAL IMPLICATIONS

It is futile to deal with effects of such magnitude in narrow terms and to ignore their astronomical implications. The facts under consideration are of such scope and significance that they tell of the earth's participation in the evolution of the solar system. The concept begins to take shape that the past of the system and of the earth as a part of it may have been different from what has been supposed and may not be impossible to discover.

Geology and astronomy should both share the credit for first inferring that the moon probably was formed by terrestrial fission. The mathematical researches of Sir George Darwin (1879) which led to that inference have naturally appealed to astronomers. His theory of fission caused by cumulative solar-tidal oscillation of the earth at an early epoch, assuming its rotation to have been rapid, appears to have had at least tentative approval in astronomical circles. Sir George, nevertheless, was not the first to suggest an origin of the moon from the earth, having been anticipated by Richard Owen in 1857.

Today another approach is possible. We may agree with Owen and Darwin that fission has occurred, but differ in regard to the cause and also the time when it took place.

Practically all the discussion of so-called "continental drift" during the past three decades has dealt with the crustal movements, in Wegenerian terms, as a slow continuous process. This is surely a serious misconception that arises in the first place out of inadequate methods and in the second place from failure to develop such evidence as is now available all over the globe. Any concept of gravitational terrestrial fission involves rapid action. The earth could not possibly be torn in two in any slow, gentle, uniformitarian way.

Although the evidence shows that the separation cannot have been a slow one, there is nothing against possible recurrence of similar events in the earth's past. Evidence which has been awaiting publication for several years proves that at the end of the Paleozoic era there was Atlantic rifting from the Atlas mountain region southward when Appalachia disappeared and the Mesozoic Tethys depression began in the same area. Still, because post-Mesozoic foldings and Cenozoic formations are divided by the rifts, the principal rearrangement of continental fragments cannot be dated earlier than late Cenozoic time. It is highly significant that the post-Paleozoic events were characterized by two phases, a traction phase with rifting and, later, a compression orogenic phase of recovery from a deformation less than fission.

GRAVITATIONAL ENCOUNTER

Two bodies in space may be infinitely far apart or may actually collide. Between these two extremes three grades of gravitational effect are known to astronomers as follows:

Grade 1, orbital perturbation;
Grade 2, tidal distortion followed by recovery;
Grade 3, fission.

All these grades come under the general term "gravitational encounter." Thus it is gravitational encounter, not the Wegener theory, that may be most profitably considered today. It is now possible to cite from earth history evidence of all three grades, but it cannot be done in this brief review.

Perturbation of the orbit of one body by the gravitation of another is a familiar occurrence in the solar system. Such variations in the orbit of the earth are always occurring, but their effects, of a climatic nature, can hardly be directly recognizable in the geologic record.

Tidal distortion is exemplified by the effect of the earth's gravitation on the shape of the moon and, conversely, by the lunar tidal changes in the shape of the earth. A larger moon mass would cause a proportionally greater distortion of the earth. Still greater would be the effect of less-

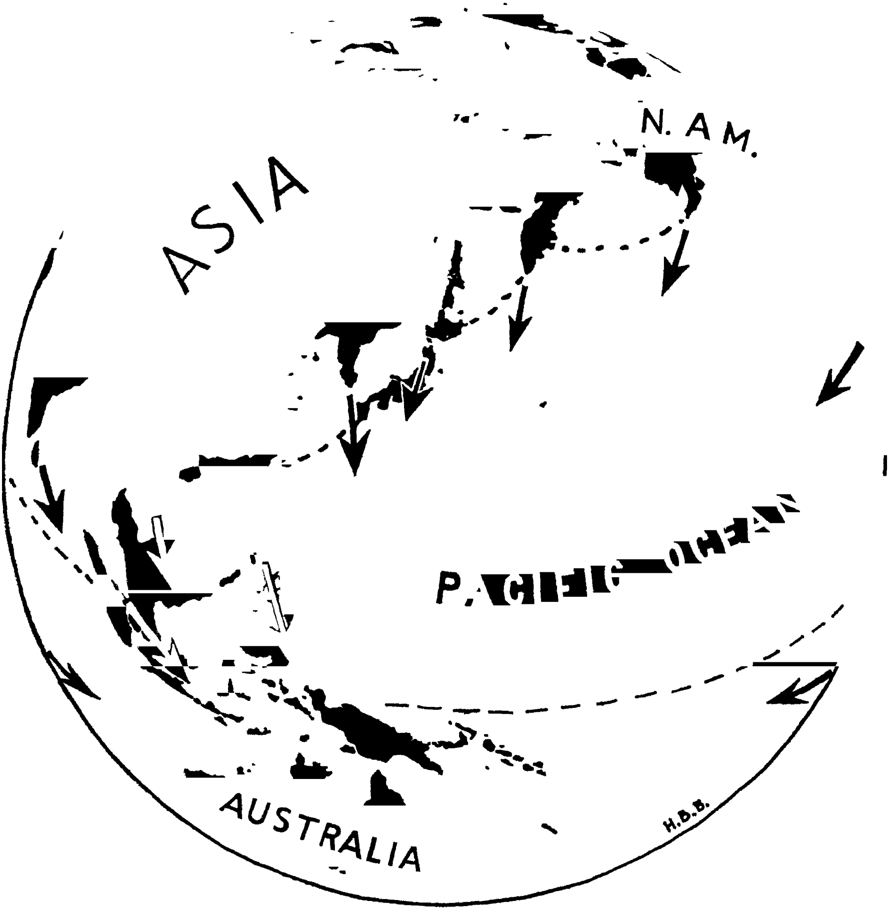

FIG. 1. The Pacific Hemisphere (the obverse of the spheroid), showing convergence of crustal fragments toward a common center of attraction

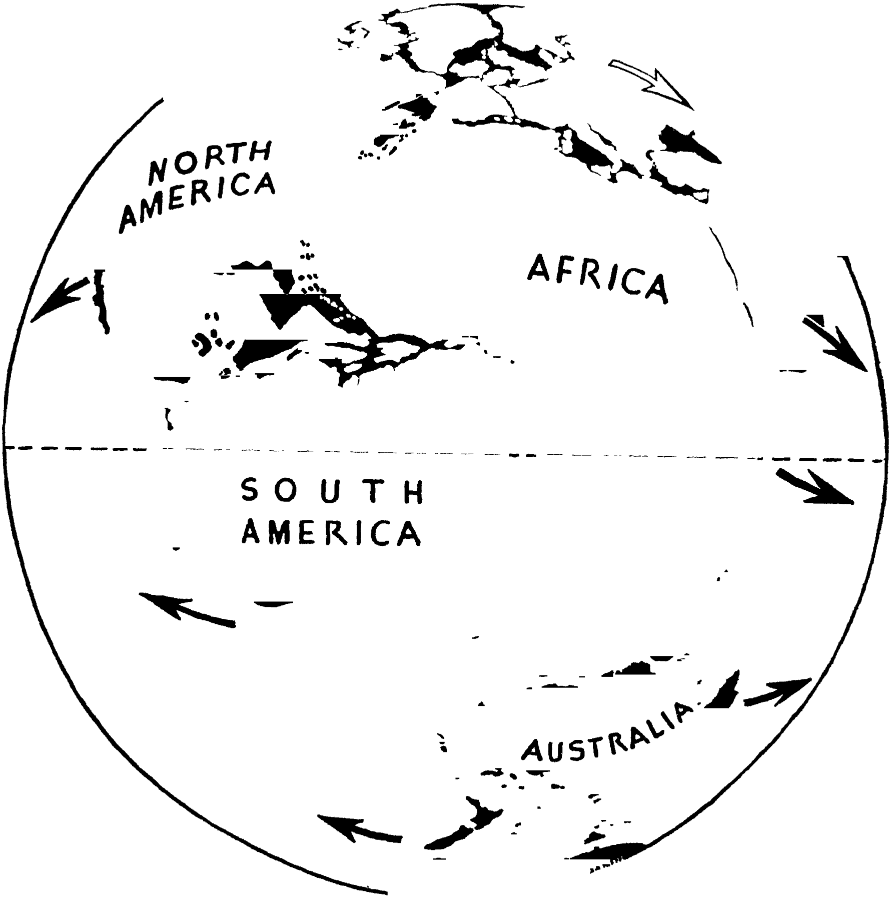

FIG. 2. The Atlantic Hemisphere (the reverse of the spheroid), showing rifting and separation

ened distance, for the tide-raising power varies inversely as the cube of the separating distance.

Any distortion of the earth's form away from the spherical must increase the area to be covered by the enclosing crustal shell, thus producing the phenomena of crustal deficiency, such as rifting and normal faulting, and any resumption of the preceding figure must result in crustal excess with thrusting and folding. The geologic record offers abundant evidence of such alternating effects which have never been satisfactorily explained by the theory of a cooling and therefore contracting earth. That theory never was anything more than a convenient assumption to explain crustal excess. Even if contraction did occur, it could never produce crustal deficiency, and its adequacy as an explanation of the known localized crustal excesses (folded mountain ranges) is far from being proved. Nor is it sure that the earth is even a cooling body; radioactive substances may be causing the subcrustal temperature to rise.

INFERENCE OF THE ABSENT

Fission results when one body is so close to a greater one that it is within the Roche limit of disruption. It has been thought by some that the planets came into being by such a biparental encounter of the maternal sun with some other body which cannot now be found. The rings of Saturn may be fragments of satellites within the Roche limit of the planet. When we find on the earth evidence that there has been a gravitational encounter at such close quarters that the earth was distorted beyond recovery and that a satellite was born, it may be inferred that the earth was within the Roche limit of some large mass. The visitor must presumably have been more massive than the earth, possibly comparable in that respect to one of the larger planets. Jupiter's mass is 318 times that of the earth; Saturn's, 95; Uranus's, 14.

There has to be an inference of something which is now absent. A hunter who found bear tracks and a scratched tree would look for a bear. Even if he failed to find the bear, he would know that one had been present, and so would his dog. A planetary mass with a cometary orbit, with an aphelion distance of 5,000 astronomical units, would not return for about 125,000 years. An aphelion distance of 10,000 units would mean a period of more than 353,000 years. The inference of the former presence of a body which is now absent will apparently have to suffice for a long while. There will be plenty of time to go on collecting the evidence which the geologic record offers of numerous epochs of tidal change of earth form. It will always be possible to recognize Grade 2 distortions by their second phase, crustal excess due to recovery, whereas the one occurrence of Grade 3, with fission, left only crustal deficiency, and that now mostly submerged beneath the oceans, practically without any following second phase and therefore without folded mountain ranges for geologists to climb to find out what had happened.

Examination of the earth and the finding upon it of signs of gravitational encounter, not just once but possibly many times, prompt further inquiry into the mechanics of the solar system. What light can earth history throw on the past of the system of which it is a member? Did other planets give birth to satellites by similar biparental encounters and fission? Would not that mode of origin explain the excess angular momentum which keeps them at their present distances? The satellites are presumably younger than the planets, and Jeans (1924) says they are too small to have been built up out of gas and hence must have begun as liquid or solid bodies. These problems, hopeless as they may appear, may not be beyond solving.

DISTORTION AND FISSION ILLUSTRATED

A mechanical model has been constructed to assist in visualizing gravitational distortion and fission, without claiming for it any particular value as evidence. The aim is merely to make plain what the evidence indicates has happened. Figure 3 shows a small tank containing a mixture of alcohol and water in which is suspended a metallic skeleton globe. A cork ball floats attached by a thread to a windlass, the ball being about the appropriate size to represent the moon in relation to the earth. On the skeleton is placed a globule of black oil of the same specific gravity as the alcohol and water. Surface tension causes the perfectly balanced globule to take a spheroidal form. Traction on the cork ball produces successive distortion figures in equilibrium, simulating gravitation. When the limit is passed beyond which recovery is impossible, fission occurs, and both the parent globule and the separated part become spheroidal.

Figure 4 shows successive equilibrium forms obtained in this way. Figure 5 is one such form adapted to illustrate the inferred fission of the moon from the southern part of the Pacific hemisphere.

DIFFICULTIES CONSIDERED

Reasonable consideration of this subject — major crustal movements and their causes — has been delayed by difficulties that should not be

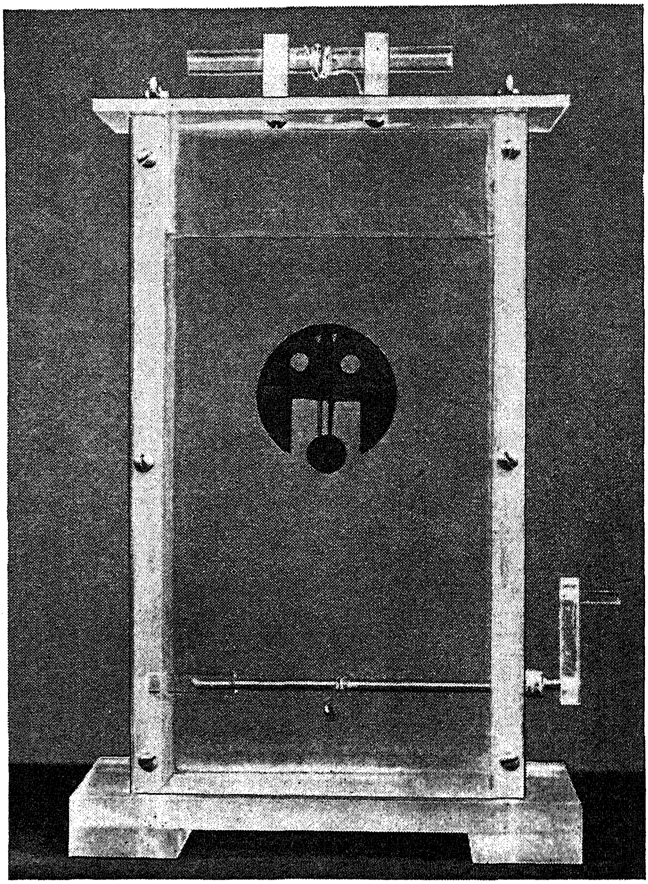

FIG. 3. Apparatus made in 1910 to simulate gravitational distortion and fission. A globule of oil is placed on a metallic skeleton globe in alcohol and water. A cork ball inside is attached by a thread to a windlass

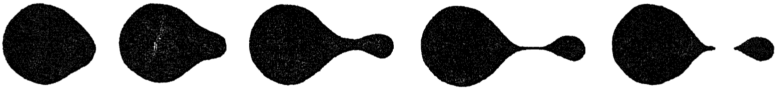

FIG. 4. Successive equilibrium forms made by an apparatus similar to that shown in Figure 3

minimized. First comes prejudice based upon orthodox geologic uniformitarianism, which insists that only causes currently known can have acted on the earth in times past. This attitude shows too much confidence in the completeness of geologic knowledge and leaves little possibility of revising our ideas of the past of the earth or of the solar system in conformity with unexpected discoveries. Not all of the ideas that were held a hundred years ago are tenable today. If Sir Charles Lyell had possessed the facts that are now demonstrable he would, we may presume, have altered his views concerning possible catastrophic gravitational effects upon the earth.

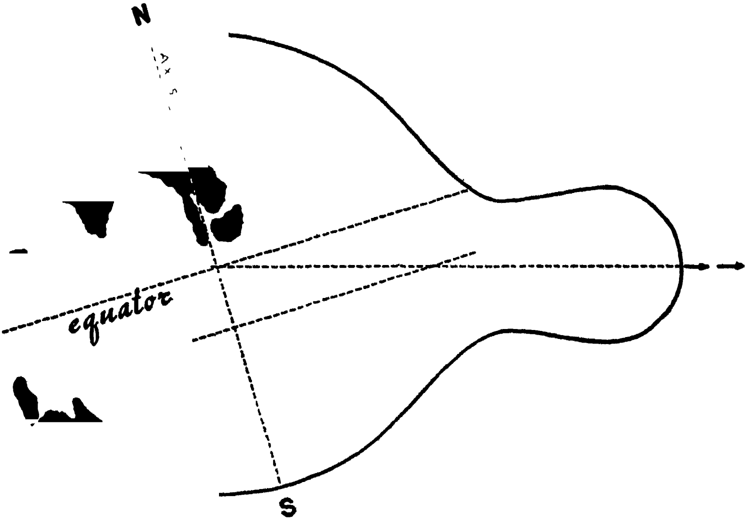

FIG. 5. Equilibrium form adapted to illustrate the inferred fission of the moon from the southern part of the Pacific Hemisphere

Secondly, and much more important, is the question concerning the volume of the ocean water. If the oceans occupy areas denuded of granitic crust which was similar to the continental sheets, and which has been lost, how could the same waters have found a place on the earlier holocrustal globe? They would have been distributed over the whole spheroidal area with an average depth of 8,000 or 9,000 feet. Geology proves that there was no such universal ocean. Throughout the geologic record the surface level of the waters of the globe was not far below the surface of the land. At the present day the same is true. The one question may be met with another: Where was the bottom of those early waters? Were they comparable in depth to the present oceans? Was their total volume the same? They were not! All the seas that are known from the early periods were of the epicontinental type and do not show signs of great depth. Nor did they cover the whole surface. Geology possesses no evidence whatever of such abyssal waters anywhere as now prevail over most of the earth's surface. Zoologists report that the fishes that are now ȧdapted for life in the depths are not archaic forms but have recently been evolved from inhabitants of relatively shoal waters. The North Atlantic floor is reported to be liberally sprinkled with shallow-water shells. In 1911 geologists of this academy were inclined to ridicule the idea that prior to the Atlantic rifting the Atlantic Ocean did not exist. Today their objections are adequately met by the Veatch-Smith charts (1939). The slopes of the continental shelves of Mesozoic rocks are eroded in gullies as great as or greater than the Grand Canyon of the Colorado. There rivers flowed 10,000 feet below the present surface of the sea. There was a time, geologically not long ago, when the surface of the sea was approximately two miles lower than the present surface of the land. On the Pacific side the evidence is of the same purport. Some scientists go as far as they can to account for the changed volume of the oceans by postulating excessive glacial accumulation on the land, and they fail before they get well started. Submarine currents have been invoked to explain away the drowned gorges, with no better success. There has been a vast accession of water upon the earth since the late Cenozoic terrestrial fission. It is now only the surface of the water that is near the level of the land; no longer is it the bottom also. The acquisition of all that water is another, and later, chapter in the story of the earth's participation in the evolution of the solar system.

Man and all the other land-dwelling creatures depend for their continued existence upon the unevenness of the surface of the lithosphere. That unevenness has resulted principally from gravitational distortion and fission. Only the simplest of arithmetic is required to disclose that, if there had been no fission, what are now the continents would be at the bottom of a world-embracing ocean. Fission saved this world from subsequent total inundation.

DETROIT, MICHIGAN

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THE VOLCANIC ROCKS OF THE GROS VENTRE BUTTES, JACKSON HOLE, WYOMING

LOUIS J. SCOPEL

THIS study deals with the structure, origin, petrography, and age relationships of the volcanic rocks of the East and West Gros Ventre buttes in the southern part of Jackson Hole just northwest of the town of Jackson, Wyoming. The Teton Range lies to the west of the buttes and the Gros Ventre Range to the east. The buttes trend north-northeast and are approximately four and one-half miles long, one mile wide, and three fourths of a mile apart.

Field work was done in the summer of 1948 as part of the summer program of the University of Michigan at Camp Davis. Thanks are due to Professor A. J. Eardley, of the University of Michigan, for suggesting the problem. The writer is especially indebted to Professor W. H. Parsons, of Wayne University, for many profitable discussions and suggestions in both the field and the laboratory.

GENERAL GEOLOGIC SETTING

The East and West Gros Ventre buttes have been mapped by Horberg[1] and Bergren[2] as eroded fault blocks. The faulting has been considered contemporaneous with the great Teton block fault. The buttes are composed of Paleozoic rocks, which have a general westward dip and are partially covered, especially toward the north, by Tertiary volcanic rocks and Pleistocene glacial deposits. In the present study the buttes were mapped in detail, and the volcanic rocks were subdivided into seven map units (Fig. 1).

The volcanic rocks of the Gros Ventre buttes consist of basic lava flows and small amounts of breccia and tuff. Flow structure is apparent in most of the lavas, which range in appearance from light-gray felsites

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[1] Horberg, Leland, *The Structural Geology and Physiography of the Teton Pass Area, Wyoming*, p. 47, fig. 10. The Augustana Library Publications, Rock Island, Illinois, Number 16, 1938.

[2] Bergren, Arthur L., Jr., unpublished master's thesis, University of Michigan, 1947.

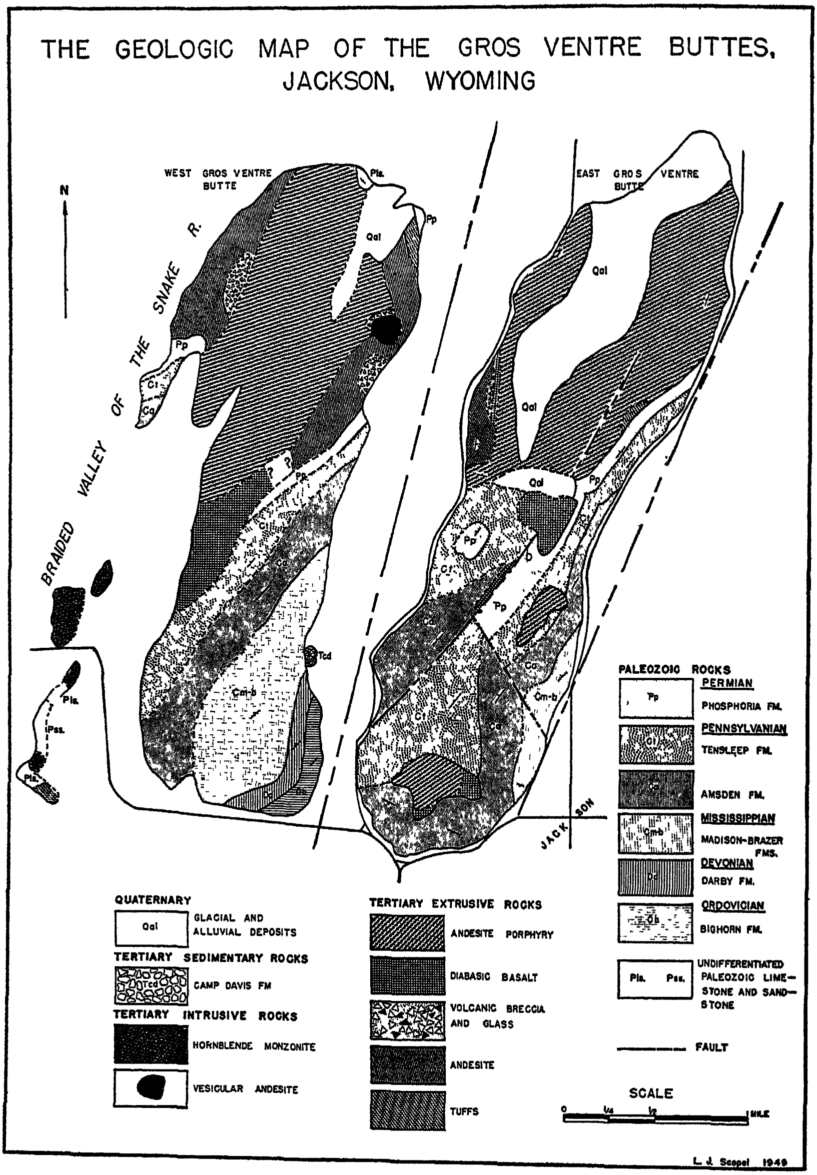
THE GEOLOGIC MAP OF THE GROS VENTRE BUTTES, JACKSON, WYOMING
WEST GROS VENTRE BUTTE
EAST GROS VENTRE BUTTE
N
BRAIDED VALLEY OF THE SNAKE R.
JACKSON
Qal
Pp
Pls.
Pss.
Ct
Ca
Cm-b
D
Tcd
QUATERNARY
GLACIAL AND ALLUVIAL DEPOSITS
TERTIARY SEDIMENTARY ROCKS
CAMP DAVIS FM
TERTIARY INTRUSIVE ROCKS
HORNBLENDE MONZONITE
VESICULAR ANDESITE
TERTIARY EXTRUSIVE ROCKS
ANDESITE PORPHYRY
DIABASIC BASALT
VOLCANIC BRECCIA AND GLASS
ANDESITE
TUFFS
PALEOZOIC ROCKS
PERMIAN
PHOSPHORIA FM.
PENNSYLVANIAN
TENSLEEP FM.
AMSDEN FM.
MISSISSIPPIAN
MADISON-BRAZER FMS.
DEVONIAN
DARBY FM.
ORDOVICIAN
BIGHORN FM.
Ob
UNDIFFERENTIATED PALEOZOIC LIME-STONE AND SAND-STONE
FAULT
SCALE
0 1/4 1/2 1 MILE
L. J. Scopel 1949

FIGURE 1

to dark-colored porphyries. These flows are cut by a few intrusive rocks, which are probably vent fillings.

THE EXTRUSIVE ROCKS

The oldest volcanic rock on the buttes is a pink to white friable tuff, which is represented by three small remnants that lie directly on Paleozoic sediments (Fig. 1). The tuff is composed of felsitic and glassy igneous rock fragments in a groundmass of volcanic dust, clay, and fine-grained calcite.

The earliest recognizable lavas are dense andesites, which are characterized by a pronounced sheetlike to subconchoidal fracture parallel to a prominent flow structure. These flows are light gray, with reddish to brownish weathered surfaces. The rock shows trachitic texture and consists of andesine laths, colorless interstitial glass, and a few microphenocrysts of hypersthene and andesine.

Several small areas of flow breccia and interbedded glassy lavas are associated with the andesite flows. The breccias are composed of small angular gray, brown, and black fragments (one-half to two inches) in a matrix of glass, which shows flow structure and weathers red. The fragments consist of trachitic andesite, various glasses, and vitrophyres with a few microlites of plagioclase. In the vicinity of the vents the glasses are devitrified and have a mottled light- and dark-gray appearance.

A few dense whitish-gray to purple flows occur which have a granular appearance and only a suggestion of flow structure. Microscopically these rocks reveal a diabasic texture of interlocking labradorite laths and pyroxene, with a small percentage of dark-brown interstitial glass. The pyroxene is a mixture of augite and hypersthene. The extrusives are diabasic basalt and contain more femic minerals than any of the other flows.

Andesite porphyry is the most abundant volcanic rock on the East and West Gros Ventre buttes (Fig. 1). It is the youngest lava of the area and has a thickness of at least six hundred feet. The thickness apparently represents many separate flows, but contacts between flows are hard to locate. Columnar, vertical, and horizontal joints are apparent, and the material has a pronounced flow structure. The weathered surface is predominantly black- and red-streaked; the fresh fracture is dark-colored, and contains prominent plagioclase phenocrysts. Petrographically the rock is composed of large corroded phenocrysts of andesine, a few hypersthene crystals, minor amounts of augite in a glassy groundmass, and plagioclase crystallites.

THE INTRUSIVE ROCKS

The igneous rock which fills a vent on the eastern side of West Butte is a whitish-gray vesicular andesite with a vitreous luster. The vesicular rock contains inclusions which range in size from about one-half inch to over twenty feet. These inclusions are composed primarily of hypersthene andesite, volcanic breccias, and glass identical with that of the flows near by. The intrusive andesite is coarser-grained than the andesite and basalt flows and consists of interlocking andesine laths, and a small amount of colorless interstitial glass. Femic minerals are scarce and highly altered, but a few crystals of hypersthene were identified.

Several small outcrops of hornblende monzonite are present along the Snake River near the main highway, southwest of West Butte (Fig. 1). The intrusive is a light-gray, fine-grained, phaneritic rock with noticeable hornblende and feldspar crystals. The monzonite contains many inclusions of hornblende, biotite, and chlorite schists, quartzites and pegmatites, all apparently of pre-Cambrian age, since these rock types are all found today in the pre-Cambrian core of the Teton Range. Monzonite is used locally as a road filler. Petrographically the rock consists of a groundmass of orthoclase and plagioclase (albite or oligoclase), and plagioclase phenocrysts, which are highly altered to calcite and sericite. Many hornblende crystals and a few augite crystals are dispersed throughout.

STRUCTURE AND ORIGIN OF THE VOLCANIC ROCKS

The lava flows and pyroclastics of the Gros Ventre buttes lie on a very uneven erosional surface, developed on Paleozoic rocks, which has a relief of at least seven hundred feet. The lavas lap down the steep eastern sides of the buttes as well as the more gentle western slopes. The relief is also apparent from north to south within each butte.

Horberg[8] has assumed that the prevolcanic surface was relatively smooth and that after vulcanism the lavas and the underlying surface were tilted by block faulting. The author believes, however, that the lavas came out on a surface of considerable relief, which was not tilted after vulcanism.

Some of the lava flows originated from a volcanic vent on the northeastern side of West Butte. The vent is filled with vesicular andesite, which contains numerous large inclusions of the adjacent extrusive rocks. A possible volcanic plug exists southwest of the same butte and is composed of hornblende monzonite. Because of its more acidic composition the writer feels that this was probably the last active vent.

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[8] Horberg, *op. cit.*, pp. 63–64.

The andesite porphyrytic lavas at the highest part of the northern half of East Butte have vertical or very steep flow structure in a rather narrow belt extending over a linear distance of approximately a mile. This zone of steep-flow structure trends northeast, roughly parallel to the eastern front of the butte. In the southern part of the butte there is evident a small fault with the same northeastern trend and in line with the zone of steep flow structure to the north. At one point on this fault a small mass of diabasic basalt has an essentially vertical flow structure. Apparently the lavas have come up as fissure eruptions along this fault and its probable extension to the north.

Several small cross faults, one of which is mapped, are present on the buttes. Relationships at other localities were too obscure to permit mapping of such faults. However, the rather sudden change of the strike and dip of the flow structure of the lavas adjacent to possible cross faults might be explained as movements of the lavas up such fissures. The eruptions must have postdated the faulting of the buttes, since the lavas used some of these faults as avenues of escape. The fault blocks were not only uplifted but were also deeply eroded, as previously stated, before the first volcanic activity.

The flows on West Butte dip, in general, to the west away from the known vent and the fissures from which the eruptions originated. The dip of these lavas is, therefore, a normal dip away from the centers of extrusions and are not necessarily due to faulting or tilting.

AGE OF THE VOLCANIC ROCKS

Colbert[4] and Love[5] have dated the volcanic rocks in the northern part of Jackson Hole as Lower or Middle Miocene because of fossils found in basic volcanic tuffs. Foster[6] has correlated the basic volcanic rocks along the eastern margin of Jackson Hole with those to the north, dated by Love, and with those on East Butte. Foster describes andesitic breccias near Elk and along Ditch Creek (east side of Jackson Hole) and hyper-

[4] Colbert, R. H., "A Miocene Oreodont from Jackson Hole, Wyoming," *Journal of Paleontology,* 17 (1943): 298–305.

[5] Love, J. D., "The Tertiary Stratigraphy and Its Bearing on Oil and Gas Possibilities in the Jackson Hole Area, Wyoming," *Oil and Gas Investigations, Preliminary Chart 27,* 1947.

[6] Foster, Helen L., "Tertiary Rocks in Jackson Hole," 1947. Unpublished manuscript.

sthene andesite and basalt flows on Flat Creek. At these places the volcanic rocks are apparent beneath the Camp Davis formation.[7] The lavas on Flat Creek are approximately five miles east of the northern end of East Butte and might possibly have originated from the buttes.

The author found a small patch of material, presumably Camp Davis conglomerate, against the base of West Butte near its southern end. The conglomerate lies in the valley which has been cut between the buttes across the volcanic material, implying considerable erosion after the igneous activity and before deposition of the conglomerate. Therefore, it may be, as suggested by Bergren,[8] that the faulting of the buttes took place before the main Teton fault, since downwarping by the latter apparently initiated deposition of the Camp Davis formation.[9] Such a sequence of events would allow time, after the faulting of the buttes, for volcanic activity and a great deal of erosion before Camp Davis time. Horberg,[10] Foster,[11] and Eardley[12] believe that the Camp Davis formation is late Miocene or Early Pliocene in age.

CONCLUSIONS

The sequence of events in the Gros Ventre buttes area may be summarized as follows:

1. Formation of the Gros Ventre buttes by block faulting.
2. Erosion of the fault blocks to a surface of at least seven hundred feet relief.
3. Vulcanism, with lavas and pyroclastics issuing from a few small vents and fissures, probably simultaneously with similar activity in the northern part of Jackson Hole in early or middle Miocene time.
4. Partial erosion of the volcanic rock.
5. Deposition of the Camp Davis formation initiated by the Teton fault in late Miocene or early Pliocene time.
6. Erosion to present-day topography.

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[7] *Ibid.* [8] Bergren, *op. cit.* [9] Foster, *op. cit.*

[10] Horberg, L., Nelson, Vincent, and Church, Victor, "Structural Trends in Central Western Wyoming," *Bulletin of the Geological Society of America,* 60 (1949): 187.

[11] Foster, *op. cit.*

[12] Eardley, A. J., and Others, *Hoback–Gros Ventre–Teton* Field Conference, 1944. Privately printed.

GENERAL SECTION

ANTHROPOLOGY, LANGUAGE AND LITERATURE,
MEDICAL SCIENCE, PHILOSOPHY, POLITICAL
SCIENCE, PSYCHOLOGY

HALF HOUSE: A PITHOUSE IN CHACO CANYON, NEW MEXICO*

RICHARD N. ADAMS

THIS report is concerned with the excavation and the materials of a pithouse in Chaco Canyon, New Mexico. The house rests in the arroyo of the Chaco River, about thirty-five feet from the southern boundary of the Chaco Canyon National Monument boundary line, nine miles east and up the Canyon from the National Park Service headquarters (Fig. 1).[1] The floor of the house is some sixteen feet below the surface of the present valley floor, in the face of the arroyo below the mesa on which Shabik'eshchee is located (Pl. I). The site was first seen when it had nearly been cut in half by the erosion of the arroyo. Brand (p. 42, n. 4) mentions a bisected pithouse which was exposed in the arroyo below Shabik'eshchee when a part of the bank fell away in August of 1936. It was not until the early part of 1947, however, that any interest in the site was manifest. At that time Mr. Gorden Vivian[2] of the National Park Service removed the contents of the fire pit and sent the charcoal to Dr. Florence Hawley for dating. Dr. Hawley judged, however, that the specimens were too short for dating; she thought they were juniper twigs, and hence they could not be relied upon for dendrochronological information.

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* The excavation upon which this report is based was carried on during the summer of 1947 by Mr. Malcolm Raphael, Miss Lucille Knudson, and myself, together with a crew of two to four Navaho Indians, in connection with the Field Session of the University of New Mexico; various students of the University gave help during the excavation. I want to thank Mr. Raphael especially for his suggestions and assistance during the entire period. Dr. Paul Reiter, director of the University of New Mexico 1947 Field Session, initiated the project and aided materially in its progress. For advice and criticism I am indebted to a number of people, but particularly to Dr. J. O. Brew, Harvard University, Dr. Irving Rouse, Yale University, and Mr. Stanley Stubbs of the Laboratory of Anthropology in Santa Fe. Dr. William H. Burt, University of Michigan, identified the animal remains and Dr. Deric O'Bryan of Gila Pueblo did the dendrochronology. Dr. James B. Griffin of the University of Michigan was very helpful in the preparation of the manuscript. To these and many others I owe thanks.

The work was undertaken with the permission of the Department of the Interior. The materials from the site are deposited in the Museum of Anthropology, University of Michigan.

This essay was presented in slightly different form to the faculty of the Graduate School of Yale University in candidacy for the degree of Master of Arts.

[1] This map was prepared from one in the National Park Service circular for Chaco Canyon.

[2] I am indebted to Mr. Vivian for information concerning the site prior to my work and for the interest he showed during the excavation.

In June of 1947, upon my request for a special project at the University of New Mexico Field Session, Dr. Paul Reiter suggested the task of excavating the site. Since it offered the possibility of self-instruction in archaeological techniques and since its depth indicated that the fill above would provide a sequence, the work was undertaken.

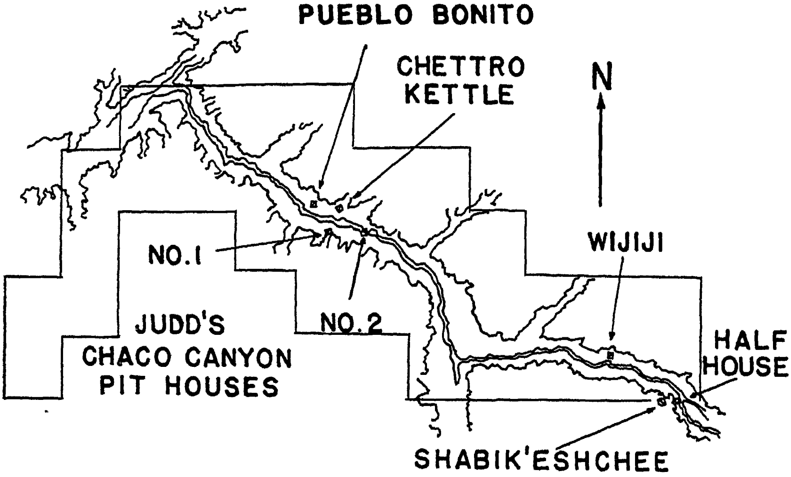

Fig. 1. A map of Chaco Canyon, New Mexico, showing the location of Half House with respect to other sites

By way of introduction I should review briefly other pithouse excavations in the canyon. In 1924 Neil Judd's report on two pithouses appeared, consisting of descriptions of one surface house and one located in the face of the arroyo (13, 399–413). While the former produced few artifacts, the latter provided materials for the main body of the report. Roberts (21) in 1929 published his findings at Shabik'eshchee village, a group of pithouses on the mesa top overlooking the site of Half House. The pottery complex from this village differs from that described by Judd for his Pit House 2, and the evidence points to later date of occupation for the house. During the 1936–37 excavation of Bc 50–51 a pithouse was discovered and excavated under the direction of Wesley L. Bliss; a brief description of it by Clyde Kluckholm is included in the general report (15, pp. 26–29, Fig. 4). Since Mr. Bliss's notes were not available, little more can be said of this report than that the excavation received attention. Though other pit dwellings have been located in Chaco Canyon, no other publications have appeared which give information on systematic investigations and descriptions of artifacts and floor plans.

The excavation of Half House was carried out on the basis of a simple scheme (Fig. 2). The face of the arroyo presented what appeared to be natural strata. Digging commenced in an area eleven by eighteen feet, directly above the house and on the edge of the arroyo bank. All cultural materials were removed according to the natural strata as delineated early in the excavation. When the floor of the house was reached at a depth of sixteen feet, the horizontal area of the pit had narrowed to the approximate diameter of the floor, fourteen feet. The hardness of the adobe and sand made the work slower than was anticipated; when a depth of seven feet below the valley floor was reached, two columns of earth four feet square were left in the inboard corners of the pit in order to lessen the amount of dirt to be removed. Upon nearing the floor we removed the earth from beneath the columns in order to reach the edge of the floor of the house.

Artifacts were placed in sacks differentiating types of material and the strata in which specimens were found. For reasons explained later, artifacts in the layer one foot above the floor were included with those taken from the floor itself. I did the laboratory work in the Museum of Anthropology at the University of Michigan, where facilities were offered by Drs. James B. Griffin and Albert C. Spaulding.

STRATIGRAPHY

As has been noted, the arroyo face provided a natural series of layers and lenses according to which the materials were removed. Each layer described here was excavated as a whole. It should be remembered that Layers 1–4 extended across the whole face of the arroyo bank, whereas the various members of Layer 5 were peculiar to the area immediately above the pithouse. Hence the division of Layer 5 into its various components was made with a view to convenience in the removal of cultural materials. Thus 5d of Layer 5 is actually partly in Layer 6 in the regular stratigraphy of the arroyo face; and the Floor Layer is entirely in Layer

6 (cf. Fig. 2 and Pl. II). The composition of the various layers was as follows:

Layer 1.—Light-colored clay and sand. No cultural materials.

Layer 2.—Darker clay and sand. No cultural materials.

Layer 3.—Sand; sporadic pieces of charcoal, some as large as 1 cm.; occasional sandstone blocks. Cultural materials found in this layer and all lower layers to the house itself.

Layer 4.—Clay; sporadic pieces of charcoal as in Layer 3.

Layer 5.—A composite layer, primarily clay, with a series of distinct yellow and red sand lenses containing pieces of charcoal and lignite, occasional deposits of almost pure clay and a considerable number of sandstone blocks. There were, in addition, a few lenses which were predominantly charcoal and lignite. The lenses of Layer 5 are labeled by a number, a letter, and a number. The initial number is 5, referring to Layer 5; the letter *R* indicates that the lens was predominantly red sand; the letter *B*, that it was predominantly sand and clay with a considerable amount of lignite mixed with it. The numbers following *R* or *B* designate lenses of each type. Other lenses of Layer 5,

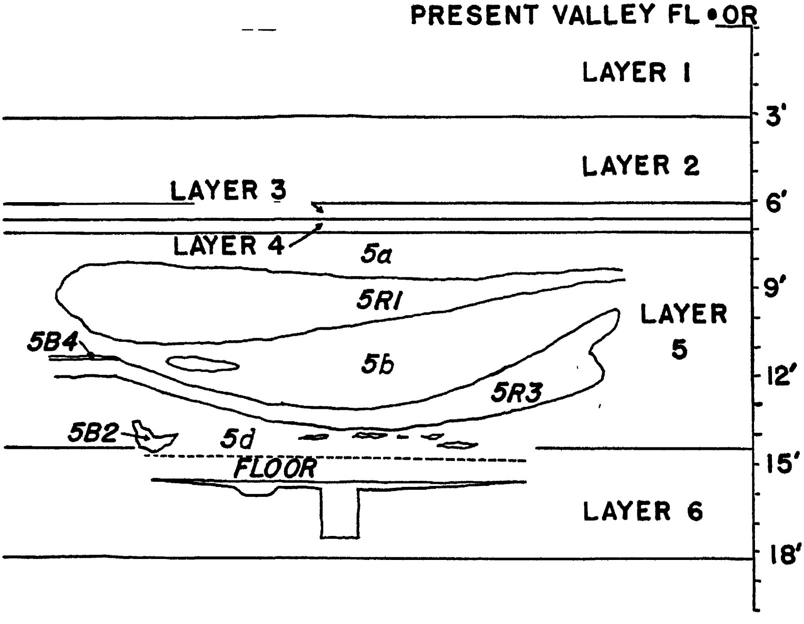

Fig. 2. The stratigraphy at the site of Half House.
See text for explanation

namely, *5a, 5b,* and *5d,* are mixed yellow sand and clay, the material of which Layer 5 is composed beyond the areas of the pithouse.

The lenses described below are those which were excavated separately for the removal of cultural materials:

Lens 5a. — Sand and clay mixture.

Lens 5R1. — Predominantly red sand mixed with charcoal and lignite; small lenses of yellow sand throughout.

Lens 5b. — Same as *5a;* throughout this lens are a series of small red sand and charcoal lenses, the same material as that found in 5R1 and 5R3, and numerous sandstone blocks, mostly red, some yellow. There was no discernible regularity in the position of these blocks.

Lens 5R3. — The right half of the exposed surface of this lens is similar to 5R1, but the left or southern half is thoroughly mixed with clay so as to become almost indistinguishable from the rest of Layer 5 in color, but the outline is still distinct. On the far left is the lignite lens, 5B4.

Lens 5d. — Same as *5a.* There is no visible distinction between *5d* and the Floor Layer, but the dividing line was placed arbitrarily with the first appearance of roofing and walling clay at one foot above the floor.

Floor lens. — The terms "Floor," "Floor Level," and "Floor Layer" designate a depth of one foot from the floor itself up to *5d.* Throughout this fill walling and roofing clay was found. The body of the noncultural material in the Floor Level was of the same type as that found in *5a, 5b,* and *5d.* Covering the floor itself, for a depth of 4 cm. at the center of the house to 1 cm. or virtually none at the periphery, was a layer of sand (mixed with small pieces of charcoal), usually yellow but red in the vicinity of the fire pit and the upright stones (Figs. 3–4, items *M* and *L*). The presence of this thin layer made it quite easy to trace the entire area of the floor.

The removal of the overburden according to the strata outlined seemed originally to be superior to the use of regular, arbitrarily defined strata. The curve of the lenses directly above the pithouse suggested that the fill was wind-blown. Upon excavating it developed that the same curve which appears on the face of the arroyo also occurred in a plane perpendicular to the exposed face. Hence if one were to imagine himself present when the valley floor was nine to twelve feet below its present level, the ground surface would show a depression very similar to those observed above pithouses found nearer to the surface of the ground today. During the excavation every attempt was made to follow carefully these curved surfaces, but some difficulty was encountered in doing it. Were the work to be done over, I believe that arbitrarily defined levels would be more satisfactory both for digging and for the allocation of cultural remains.

ARTIFACTS

The artifacts from Half House and the fill above it provide us with nothing strikingly new. Similar types of almost all finds have been described or illustrated in other publications on excavations in the Southwest. For this reason it seems neither necessary nor profitable to give detailed explanations and descriptions concerning the materials. Instead, the data are presented primarily according to the distribution by strata, with descriptive notes added only for the sake of clarity. Each list is prefaced with a summary note, together with other relevant information. With the exception of the pottery data, no differential comparative notes have been made about the various layers, since there is such uniformity and since the paucity of the remains does not suggest the need for this treatment in a cultural period which is better known from other sites.

The materials from Half House are described in the following categories: pottery, unfired clay objects, stone, bone and shell, other bone remains, and walling and roofing clay. Besides the objects listed here, a number of pieces of charcoal were found and sent to Dr. Deric O'Bryan for dating. His findings are discussed in the section on chronology.

Pottery

Sherds from Half House and the fill above it were classified without the benefit of a comparative sherd collection. Mr. Stanley Stubbs went over all the pottery remains and introduced order into what had hitherto been chaos. Dr. J. O. Brew examined the orange ware, and I have followed substantially his suggestions. I am grateful for their assistance, but, of course, accept responsibility for opinions expressed here. Use was made of a number of publications, and I have employed only nomenclature which seemed to me to be generally accepted or adequately descriptive. If the sherds fitted into no standard type, I have used a generally descriptive label. All sherds of this last category were badly battered, and no space has been devoted to them in the report. Both the manuals on Southwest pottery (5, 11) and various monographs (2, 7–10, 15–19) were employed in the examination.

Instead of giving a detailed description of the pottery from Half House I have presented the information in tabular form. The comments which follow are made with reference to Table I. The data from Layer 3, though included in the table for completeness, will be excluded from consideration in the discussion, since so few sherds were found in it.

TABLE I

PERCENTAGE OF POTTERY BY TYPE IN EACH LAYER

Pottery	Floor	5*d*	5R3	5*b*	5R1	4-5*a*	3
Plain Gray	84.3	78.1	72.2	76.1	72.2	49.2	71.5
Fugitive Red	0.7 *	8.6	14.3	11.1	14.0	2.0	..
Corrugated †	..	..	..	1.6	2.6	14.8	14.3
Lino B/G	0.7	..	..	1.6	..	1.2	..
La Plata B/W	5.9	8.6	11.8	7.1	1.4	..	..
White Mound B/W	..	..	..	..	2.6	..	..
Red Mesa or Escavada B/W	..	0.9 ‡	0.4 ‡	..	..	..	..
Kiatuthlanna B/W	..	..	0.4 ‡	..	1.7	18.5	14.3
Unidentified slipped ware	..	..	..	1.6	0.9	9.9	..
Orange Ware	6.7 §	3.8	0.8	0.8	2.0	3.7	..
Smudged Ware	1.5	..	..	..	2.6	..	..
Total number of sherds per layer	134	105	245	126	349	81	7

* Fifty-four red sherds coming from a single olla are counted here as one sherd (Pl. VI). The paste of all this ware was the same as that of the Plain Gray.

† All corrugated sherds were of the band type. Whether they are to be classed as Kana'a Gray or full-body corrugation cannot be determined in the majority of the sherds since they are too fragmentary. For the same reason it is impossible to say whether they are predominantly continuous-coil or ring-coil (Pl. VIII, 3, 6, 10).

§ Four of the twelve sherds found in this layer formed a portion of an Abajo R/O bowl which had secondary working as a scraper. This makes the total count of sherds for this layer nine instead of twelve (Pl. IX, 5).

‡ Twelve sherds from 5*d* and ten from 5R3 were all part of a single bowl. Hence in calculating the percentage for these layers I have counted these sherds as one for each layer.

It will be noted that in the bottom five layers the combined Plain Gray ware and Fugitive Red ware amount to about 75 per cent of the pottery present. The two early forms of Anasazi painted wares, La Plata Black-on-white and the Orange ware, appear consistently from the Floor up through 5R1. It is only in 4–5*a* that slipped black-on-white ware and corrugated ware really make their appearance; there is over 25 per cent of the former, the majority of which is Kiatuthlanna Black-on-white. The Escavada or Red Mesa Black-on-white bowl which appears in 5*d* and 5R3 presents something of a problem. Since there is nothing comparable to it elsewhere in the site and since the sherds occur within a relatively clearly limited area, it seems apparent that it is intrusive. Both these pottery types are common in the lower portion of Chaco Canyon, but here, in this stratum, they are definitely out of context.

The Orange ware itself displays an evolutionary sequence, beginning with the bowl fragment (Pl. IX, 5) from the floor, an Abajo Red-on-orange piece, and developing into a type very similar to if not the same as Morris's La Plata Black-on-red.[3] There seems little doubt that this ware is intrusive in the Chaco area, very probably having come in from the north or northwest, either in a few pots or as a technique employed by some migrant potters.[4]

The most significant thing about the pottery complexes of the various strata of the Half House site are the correlations they make possible with the pottery of Shabik'eshchee and Judd's Chaco Canyon Pit House 2 (Pls. VII–VIII). Both Shabik'eshchee and the bottom three strata of the Half House site have the following in common: predominance of Plain Gray ware, some Orange ware,[5] and an unslipped black-on-white ware. If I interpret Roberts correctly, Shabik'eshchee village has relatively more of the unslipped black-on-white ware than do the strata at Half House. In neither place are there corrugated sherds or slipped black-on-white pottery. Common to both the 4–5*a* strata of Half House and Judd's Pit House 2 are: Plain Gray ware, corrugated ware, and a slipped black-on-white ware. Gladwin believes that the black-on-white ware described in Judd's report is very similar to that which Roberts calls Kiatuthlana Black-on-white, the same ware as that found by Gladwin (7, pp. 41–48) at White Mound and Wingate. In the Half House strata as a whole the Kiatuthlanna Black-on-white overlaps only slightly La Plata Black-on-white and is roughly correlated in appearance with the corrugated ware. Lenses 5*b* and 5R1 seem to represent a transitional stage between the Shabik'eshchee pottery complex and that of Judd's Pit House 2. The disappearance of La Plata Black-on-white and the emergence of slipped wares and corrugated wares represent a distinct change in pottery decoration and technology. A more accurate comparison between these three sites is impossible without sherd counts from Shabik'eshchee and Judd's site.

Unfired Clay Objects

From 5R1 were taken two small rolls of slightly fired clay, apparently coils intended for use in the construction of a vessel (Pl. X, 6). One was 4 mm. long, the diameter varying between 6.7 and 7.6 mm. The other was 30 mm. long, with a diameter of 8.8 mm. The paste of both is the same, being gray and fine, and with any temper in it invisible with the aid of a small magnifying glass.

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[3] I am indebted to Dr. Brew for pointing out this sequence.

[4] Brew (2) and Morris (19) provide descriptions of these two red or orange wares. The term "Orange ware" used here includes both.

[5] Roberts (21, p. 117) refers to some of his sherds as "red"; Dr. Brew has suggested — and it seems reasonable under the circumstances — that they are in fact the same general type as my "Orange ware."

From *5d* was taken an unfired brown object with a punctate design (Pl. X, 2). It is not unlike the clay pipes and effigies which Kidder (14, Figs. 110a, 150a) shows in his collection of artifacts from Pecos. The Gleeson site produced a number of clay figurines, one of which is similar to this specimen from Half House (6, p. 50; Pl. XVIh).

Stone

There is little that is unique about the stone remains from the Half House excavation. With the exception of a few objects on the floor, everything found was in the nature of waste material such as manos and a piece of metate, irregular flakes, and waterworn pebbles. It is evident that the stone items from the floor comprise for the most part things either too clumsy to transport or easily replaceable items picked up locally, namely, metates, manos, hammerstones, polishing stones, scrapers, odd cores and flakes, concretions that had been variously employed, and a fragment of a point. By far the largest number of the artifacts are of quartz or sandstone. The almost complete absence of projectile points, knives, and other small stone objects does not mean that they were not used.

Floor (Pl. III). — The most prominent stone implements from the floor were the three metates, the first of which was supported by three small piles of slabs, evidently in the position in which it had been used. The other two were placed on end against what had been the wall of the house. All three were of the open trough, open-at-one-end, type, and were roughly triangular. Their dimensions are: No. 1, 1.65′ × 1.35′ × 0.3′; No. 2, 1.7′ × 1.7′ × 0.4′; No. 3, 1.8′ × 1.75′ × 0.3′. There were also three manos, the first of which was well worn (No. 1, 0.72′ × 0.4′ × 0.08′; No. 2, 0.7′ × 0.4′ × 0.22′; No. 3, 0.75′ × 0.45′ × 0.15′). Other stone artifacts included a waterworn pebble used as a hammerstone (125 × 66 × 48 mm.); a bowl-shaped sandstone concretion (120 mm. in diameter, 58 deep, 22 thick), thoroughly reddened, found directly above the fire pit on the level of the floor; a concretion shaped like two soft balls which had been pressed together and had stuck, with one end pecked, and evidently it had been used as a hammerstone; a small polishing stone; a core and four flakes.

Layer 5d. — The inventory of stone artifacts from this layer includes: three flakes; three hammerstones (66 × 58 × 55 mm.; 77 × 75 × 68 mm.; 75 × 67 × 54 mm.); a mano (182 × 105 × 23 mm.); a portion of a flaked knife or projectile point (29 mm. wide, 5 thick, and 54 long between the two broken ends); and a flat grinding stone with a pecked surface. The use to which this stone was put is problematic. Though one surface is flat and pecked, the other is convex and smooth. Its size (140 mm. in diameter and 26 thick at the center) indicates that it had not been used for grinding any large quantity of material.

Layer 5R3. — The stone artifacts from this stratum include five flakes, a polishing stone, a hammerstone (59 × 70 × 64 mm.), and a broken metate of the same type as that found on the floor.

Layer 5b. — Three flakes, a core, a scraper with a small concretion, and a mano (200 × 94 × 50 mm.) occurred in this stratum.

Layer 5R1. — Here were found thirteen flakes, four cores, a hammerstone (65 × 48 × 39 mm.), and four small scrapers. The scrapers, taken together with that found in Layer 5*b*, present something of a problem. They average 34 × 39 mm., with thicknesses ranging from 10 to 23 mm. (the scraper from 5*b*). The long edge of each one is sharp, the other rough; they are convenient for grasping in one hand and may have been used for cutting, smoothing, or scraping small wood, bone, or shell implements. In view of the evidence for the rather good flaking among the Anasazi, the crudeness of these tools suggests that they may not represent any type at all. There is little evidence of secondary flaking, and I have not seen any reference made to them by other writers.

There were also in this stratum two manos (192 × 105 × 34 mm.; 171 × 102 × 29 mm.) and perhaps a third, a large stone (225 × 95 × 40 mm.), which had one surface pecked and which may represent the initial stage of preparing a mano for use.

Layer 5a. — One stone flake was found in this stratum.

Bone and Shell Artifacts

Worked bone and shell items were few; among them were bone awls, a bodkin, and a fragment of a shell bracelet.

Floor. — Three bone awls: two of the type described by Kidder (14, p. 217) as *Class a;* one probably worked from the humerus of a dog, the second, from the radius of a jack rabbit, shows marks of gnawing. The third is in Kidder's *Class c;* it is a particularly fine piece, with the head partially worked and the entire body well smoothed and polished.

Layer 5d. — Two broken femurs of a jack rabbit: one highly polished, with teeth marks; the other displaying a number of scratches.

Layer 5b. — Three fragments of a long, flat awl or bodkin, 8 mm. wide at the broad end, probably about 150 mm. long originally, and approximately 1.5 mm. thick at the center. It is pierced by a hole, 1.5 mm. in diameter, located on the center line, 5 mm. from the broad end.[6]

Layer 5R1. — Fragment of a shell bracelet, 61 mm. long, 5 × 2 mm. thick. It has been identified as a marine pelecypod, but both Mr. Robert Drake, formerly of the University of New Mexico, and Mr. Aurèle LaRocque, formerly of the University of Michigan, say that it is too fragmentary to permit of further identification. It is rather typical of many such bracelets found in a number of sites in the Southwest, including one similar fragment from Shabik'eshchee.[7]

Other Bone Remains

The following is an inventory of the bones found at the Half House site, as identified by Dr. Burt:

Floor. — *Lepus californicus:* 1 femur head, 1 femur, distal end, 1 humerus head, 1 ulna head, 1 femur, 1 astragalis, 3 calcanei, 4 tibiae; *Sylvilagus:* 1 lumbar vertebra, 1 distal end of humerus, 1 radius, 1 ulna, 1 mandible; *Cynomys:* 1 radius; *Neotoma:* 2 mandibles.

Layer 5R3. — *Cynomys:* 1 humerus, 1 mandible, 1 distal end of humerus, 1 head of a femur, 1 radius, 2 ulnae. Dr. Burt suggested that all except the first listed humerus very likely came from the same young animal.

Layer 5b. — *Lepus californicus:* upper right row of teeth; *Cynomys:* 1 mandible.

Layer 5R1. — Three fragments of bird bones, unidentified.

Walling and Roofing Clay

As has been mentioned, the distinction between 5*d* and the Floor Layer was made on the basis of the presence of pieces of walling and roofing clay in the fill up to one foot above the floor. These specimens were found irregularly throughout this fill. Sixty pieces were recovered in sufficiently good condition to warrant preservation.

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[6] See Roberts (21), Pl. 25d, for a similar tool.

[7] Roberts (21), p. 142; Pl. 30a.

Description (Pl. X, 7).—The pieces showed one or two parallel impressions of branches or logs. The clay ranged from 15 to 60 mm. in length, and the calculated diameter of the wood which made the impressions ranged from 20 to 140 mm. The pieces were roughly triangular in cross section. All wood impressions were smooth, but some showed lines in relief running parallel to the length of the branch. Whenever two adjacent impressions were on the same piece of clay, they were approximately parallel. No impressions appeared at definite angles to each other. Most of the remains showed evidence of having been stained with smoke on the area exposed between adjacent impressions. There are no finger impressions on the smoked areas, but they are not uncommon on the opposite side. The smoked area invariably appears on one corner of a piece that would approximate a triangle in cross section. The clay was full of small pieces of charcoal, lignite, and other impurities. It is apparently the same as that used in the plastering between the slabs and in the corners of the fire pit.

Inference.—The framework was composed, to judge from the evidence given above, of a series of parallel stripped branches, some of which were dried, and so left longitudinal cracks. There was no evidence of a cross framework. Most of the branches were between 20 and 80 mm. thick; a few approached 140 mm. thick. With almost no exceptions there was a space of 4 to 15 mm. between branches. It appears that the moist clay was pressed against the outside face of this frame, especially between the cracks, possibly also on the outside surface of the branches. The clay was seldom pressed more than halfway through the cracks, and the inside was left unfinished. It is this small inside area of each piece that is smoked. There was little evidence that these pieces had been exposed to considerable heat or that the branches on which they were pressed had been burned. Some have a slight yellow coloration toward the smoked portion, but an equal number do not. Several pieces have been smoothed on the outside, though most are broken and show only that the clay was applied heavily.

After examining the remains Mr. Volney Jones of the University of Michigan said they were not clear enough to permit identification of the wood and that they have little botanical significance. The sizes of a few pieces over 100 mm. in diameter indicate that the branches were cottonwood or pine, both of which grew in the Chaco area during this general era.

DESCRIPTION OF HALF HOUSE

The description of the pithouse which follows will be easier to follow if Figures 3 and 4 and Plates III–V are kept in mind.

Half House was circular, roughly 14 feet in diameter. Its depth is uncertain. Though the floor was clearly outlined on the arroyo face, there were no external indications of walls such as are shown clearly in the photograph of Judd's Pit House 2 (13, Pl. 2, photograph 2). There is evidence that the house was at least 1.2 and not more than 2.5 feet deep. First, metates 2 and 3 were found leaning against what must have been the wall, with their point of contact 1.2 feet above the floor. Secondly, when the pit was being dug for the construction of the house, the stratum which I have designated Layer 5 had begun to form, for the line distinguishing Layer 5 from Layer 6 occurs on both sides of the house, but not in the area directly above the house. This line of division is also 1.2 feet above the floor. Further, the even line of the bottom of 5R3 over the northern part of the house (to the right of the fire pit in Fig. 2) makes it clear that the walls could not have been more than 2.5 feet high above the floor. And, lastly, the rather sharp angle formed by the left side and the bottom of 5B2 indicates that at the time this lens was deposited the angle made by the wall with the horizontal still remained. The top point

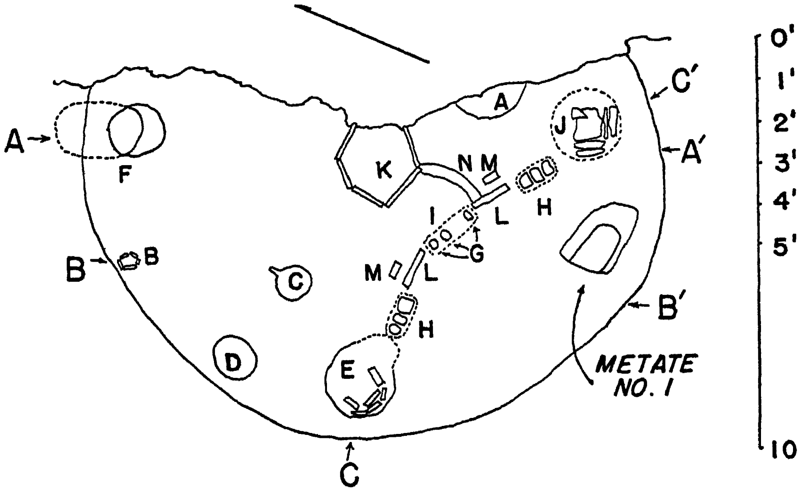

FIG. 3. Floor plan of Half House. (See text for explanation.)

of 5B2 is about 2 feet above the floor. A reasonable estimate for the depth of the house, in the light of these data, is 1.5 to 2.0 feet. The lack of any indication of a ventilator would tend to support this conclusion of a shallow pit.

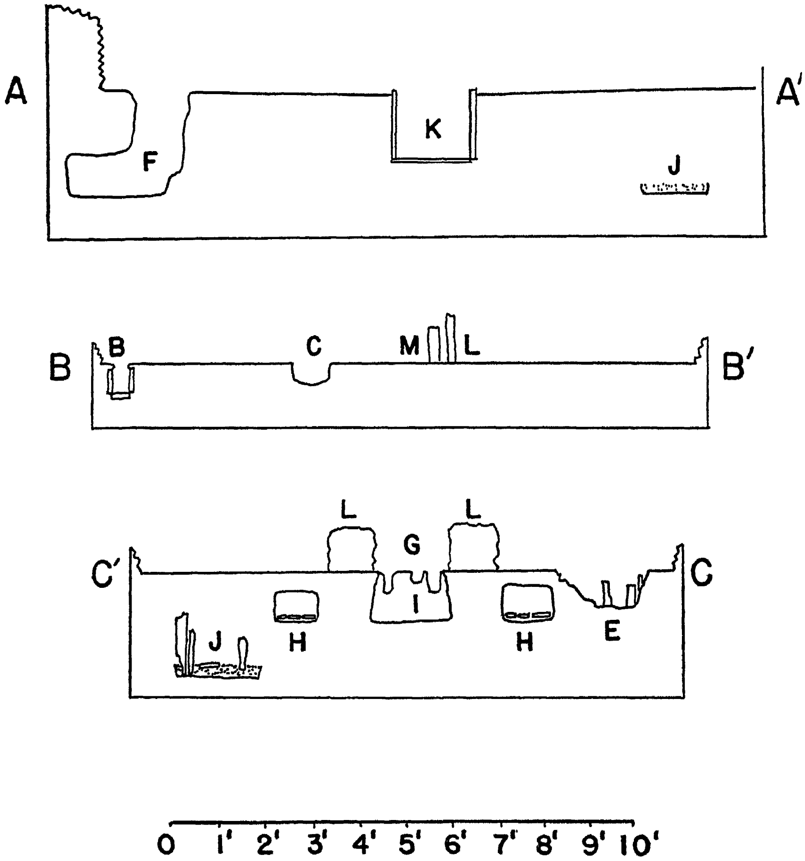

FIG. 4. Cross sections of floor plan of Half House. (See text for explanation.)

The architectural features of the floor of the house are as follows:

1. Floor depression: 1.7′ in diameter, 0.4′ deep; clay thoroughly reddened, indicative of exposure to heat; filled with same layer of sand which covered the floor. (Fig. 4*A*; Fig. 2.)

2. Small slab-lined pit: greatest diameter, 0.5′, smallest diameter, 0.33′; depth, 0.6′; filled with lignite and sand. (Figs. 3*B* and 4*B*.)

3. Floor depression: 0.7′ in diameter, 0.4′ deep, with slot extending north for 0.2′. (Figs. 3*C* and 4*C*.)

4. Floor depression: 1.2′ in diameter, 0.33′ deep; four sherds from a broken Abajo Red-on-orange bowl worked into a scraper found in it. Like depression *C*, this one was filled with the sand layer which covered the floor. (Fig. 3*D*.)

5. Rough slab-lined pit; maximum length, 2.5′, maximum width, 1.75′, depth, 0.75′; major area enclosed on three sides by a series of crude slabs; filled with lignite and clap; rim of a plain gray culinary jar found in this pit. (Figs. 3*E* and 4*E*.)

6. Large lignite-filled pit: plastered bottom and sides up to 2″ above the bottom; diameter of aperture on the floor, 1.35′, at a depth of 2.1′ the bottom is 2.15′ × 1.35′. To what use this pit was put is not clear; no artifacts were found in it, nor was anything buried beneath it. (Figs. 3*F* and 4*F;* Pl. V.)

7. Three small postholes dug into lignite fill in pit *I* (see No. 9, below); filled with red sand, the same as that which covered the floor in this area. (Figs. 3*G* and 4*G*.)

8. Two cavities under the floor: slab bottoms, lignite fill; dimensions: west cavity, 1.25′ × 0.55′ × 0.75′; east cavity, 1.2′ × 0.55′ × 0.6′; the slab bottoms of both these cavities are 1.0′ below the floor of the house. (Figs. 3*H* and 4*H;* Pl. IV.)

9. Rectangular pit 0.4′ wide, 1.0′ deep, 1.7′ long at the bottom, 1.45′ long at the floor level; same type of fill and same depth as the two subfloor cavities (*H*); in this lignite fill were placed three posts, as evidenced by the postholes (*G*). (Figs. 3*I* and 4*I*.)

10. Subfloor fire pit: 2.2′ below the pithouse floor, set in circular depression 1.75′ in diameter, packed with lignite and charcoal; highest upright slab 1.3′ high; no artifacts found in association. (Figs. 3*J* and 4*J;* Pl. 4.)

11. Main fire pit: six-sided, slab sides and bottom; approximate diameter, 1.85′, depth 1.35′; well constructed of tight-fitting slabs, plastered corners and cracks; stone thoroughly reddened. (Figs. 3*K* and 4*K;* Pl. III.)

12. Two large upright slabs; crudely formed, each approximately 1.18′ × 0.1′ × 1.0′. (Figs. 3*L* and 4*L;* Pl. III.)

13. Two smaller upright slabs; well-shaped rectangular blocks, each

approximately 0.5′ × 0.2′ × 0.75′; each is paired with one of the larger slabs (*L*). (Figs. 3*M* and 4*M;* Pl. III.)

14. Clay lip or ridge extending from crude eastern upright slab (*L*) to southern point of fire pit (*K*); 0.3′ wide, 0.2′ high. This ridge of clay separated easily from the floor, indicating that it had been placed there after the floor had been well packed by use; there were no indications of a symmetrically placed mate to this ridge running from the fire pit to the large west slab (*L*). (Fig. 3*N;* Pl. III.)

The possible significance of certain of these floor features will be discussed separately later on.

Before concluding this section on Half House it should be noted that the house has the same internal division as is found in some other Anasazi pithouses. The northern part, in which one metate is placed ready for use and two others are set against the wall, served domestic needs. Apparently the southern part was devoted to other purposes. The paucity of artifacts on the floor indicates that the last inhabitants carried away everything worth taking. Metates and manos, which are not readily portable, broken pottery, odds and ends of stone pieces, and a few bone awls were the only materials left. The excavation revealed footprints in the northern half of the floor; these will be discussed later.

The construction of the roof of the house and the walls above the ground must, of course, be inferential, but there are certain things which should be noted. Apparently there were no postholes in the floor for roof supports.[8] It has been suggested[9] that the three large features, the subfloor fire pit (*J*),[10] the rough slab-lined pit (*E*), and the lignite-filled pit (*F*), all stand in the relative positions of three of the four postholes one would expect to find in a pithouse of this nature. The objection to this explanation is the fact that, even if they had at one time been used for postholes, their later functions obviously varied; hence we are still left with the problem of a house with no visible means of support in its later history. The most likely answer is that the major post supports were outside the house proper. If we do not accept this solution, we must turn to

[8] Cf. Hurt (12). In a brief description of the site of a Modified Basket Maker house in the Canyon de Chelley he states that a superficial examination revealed no postholes. Brew (2, pp. 187–188) found at his site, Ab:7:13, only one pithouse, Pit House *N*, which has no evidence of postholes. According to Roberts (21), four postholes were standard at Shabik'eshchee, but House *J* had twenty-two. This situation would be intermediate between the use of primary roof supports and a whole series, as may have been true of Half House.

[9] By Dr. Brew in conversation.

[10] Italicized letters in this section refer to Figures 3 and 4.

the evidence provided by our study of the walling and roofing clay. It suggests that the covering was of parallel branches or logs, which would have had to be either uprights or parallel horizontals leaning against a series of uprights. Both Roberts (22, Fig. 3) and Smiley (23, Fig. 40) postulate this latter type in their reconstructions of pithouse superstructures. In such a type, however, a series of heavier supports really should be present for the framework, and the evidence from Half House does not indicate that it was.

The evidence does not seem sufficient to enable us to accept one of these possibilities with certainty, but in view of the locus of the site and the fact that we did not excavate around it, and hence did not find a possible series of upright supports, the type of reconstructions of Roberts and Smiley, made on better data than were available at Half House, seems likely.

CHRONOLOGY

All the specimens of charcoal examined for help in dating are from piñon trees. Since none have outside rings, there is no way of determining dates of cutting. The only one that contains the core of a branch is No. 6599. Six pieces (Nos. 6598, 6600–6602, 6605, and 6606) could not be dated owing to their small size or the unsuitability of the wood for such work.

Table II gives Dr. Deric O'Bryan's findings on the charcoal specimens sent to him.

Since no piece of charcoal provides an outside date, we have hardly an indication of the date when this wood was cut, if indeed it ever was. The dates of the charcoal from 5R3 suggest that the fill from which they were taken accumulated during or after the 740's. This would tend to show that the outer date of the specimen from the Floor Level, No. 6599, may not be far off, probably not more than twenty or thirty years. The rate of deposition in this region is very irregular and is unreliable for calculations, but the maximum depth of 5R3 above the floor of the house is four feet, the minimum a little under two feet. Under the circumstances it would be reasonable to estimate the time of the beginning of the fill over the house to be between 700 and 740 after Christ. The end of the last occupation of the house would presumably be not too far from this date. Consequently, the occupations of Half House can be placed earlier than that of Judd's Pit House 2, to which the date of 777 is usually assigned.

TABLE II*

DATA ON CHARCOAL SPECIMENS FOUND AT GILA PUEBLO

Catalogue No.	Stratum	Dates		Correlation
		Inside	Outside	
6599	Floor	⊙– 614	691 (doubtful)	. .
6603A	5R3	– 599	653+ –	Good
6603B	5R3	– 599	644+	Fair
6603C	5R3	– 597	653+	Good
6604A	5R3	– 634	741+	Fair
6604B	5R3	– 623	701+	Poor
6604C	5R3	– 651	748+	Fair
6604D	5R3	– 629	699+	Good

* In a letter dated October 20, 1947, Dr. O'Bryan made the following additional notes: "Catalogue Numbers 6603 A and C and 6604 D show very good correlations with our Chaco and neighboring Lukachucai master charts, and specimens 6604 A and C furnish fairly reliable dates. Number 6599 had extremely tight rings and showed some distortion; however, I am quite sure that the date is within a year or two of being right (allowing for missing rings, etc.)."

All dates are after Christ. The symbol ⊙ preceding the 614 in Column 3 means that the piece of charcoal in question contains the core of the branch; the rest of the specimens do not.

After the floor of the house had been cleared, a test trench 2 feet deep and 0.8 foot wide was cut from the exposed southeastern corner of the floor across to the center of the back. It revealed the subfloor fire pit (Figs. 3*J* and 4*J*) and the eastern subfloor cavity (Figs. 3*H* and 4*H*). The photograph shown in Plate IV gives a view directly down this trench. No artifacts were found in the trench, however. Lack of time prohibited further excavation below the floor, but certain tentative conclusions may be based on the information at hand.

It seems certain that the deposit of earth in which Half House is situated may be classed as Bryan's Deposition II (3; 4: 226–229). The lack of artifacts below the house, as compared with their consistent appearance in the fill above the house in Layers 5, 4, and 3 and in the continuation of those layers along the arroyo face, indicates that Half House was either contemporaneous with Shabik'eshchee village or earlier than it. For it will be remembered that Shabik'eshchee is located on the mesa immediately above Half House; and to imagine that a population of any size could live on the edge of a mesa without availing themselves of the opportunity to dispose of waste and refuse over the side would be difficult. We would expect that, if Shabik'eshchee preceded Half House in time and if any deposition was going on, the sand and clay under the pithouse would reveal Shabik'eshchee materials. Since they do not, if we take into account the similarity in pottery complexes between the two, we would conclude that Half House was very nearly contemporaneous with the village, if not slightly earlier.

Against this conclusion, however, is the fact that the lack of materials beneath the floor is purely negative evidence, and there are certain indications that Half House does not represent the same culture as Shabik'eshchee. In view of their proximity certain differences which will presently be noted in detail suggest a difference in time; the alternative view is that Half House represents a separate social group with some distinct cultural elements not present in the village.

SUMMARY AND INTERPRETATION

Half House is a pithouse in Chaco Canyon, located in the valley below Shabik'eshchee village about nine miles up the canyon from Pueblo Bonito. It was exposed in the side of the arroyo, sixteen feet below the present valley floor, when the wash cut away the bank. The collection of artifacts, and particularly the pottery complex, indicates that the house represents a culture similar to that of Shabik'eshchee. It was probably occupied sometime between 700 and 740 after Christ. The architecture of the house manifests some characteristics which have not heretofore been reported from any other pithouse excavation in the southwest. Among them are subfloor cavities placed symmetrically with regard to certain floor features and the use of two pairs of parallel stones in the north-south division of the house instead of the single row frequently found elsewhere. In other respects the house obviously belongs to the cultural era called Basket Maker III, or Modified Basket Maker, in the Anasazi culture area. The discovery of a fireplace below the floor with apparently little connection with the house itself suggests an earlier but probably unrelated occupation.

Though the artifacts found at the site are too few to enable us to improve our understanding of the late Basket Maker culture, the variation in architectural features suggests a local diversity in this region which has yet to be adequately delineated. The pottery complexes in the several strata of the fill above the house provide a sequence which is in accordance with that usually attributed to the Anasazi culture. The slight, but consistent, appearance of Orange ware indicates a constant contact with other phases of this culture.

Turning to an interpretation of our Half House material, I shall first consider indications concerning the course of events during its occupation, and finally touch on some problems presented by the data.

At the site of Half House two separate and distinct occupations can be postulated. The first is based on the remains of the single subfloor fire pit (Figs. 3*J* and 4*J*). This hearth, if I am correct in my estimate of the ground level at the time of occupation of the house itself, was constructed at a time when the valley floor was about four feet lower than it was during the actual occupation of the house. No artifacts, besides the hearthstones themselves, were found in association with this fireplace or in the test trench across the pithouse. It is possible that it was constructed as part of the house, but the composition of the fill above it could not be distinguished from that around it, though that of the other subfloor features could be differentiated.

If this subfloor pit is earlier than the house, then the house could not have been dug until about four feet of deposition had covered the area (Figs. 2–4). In any case, there are suggestions of two separate occupations of the house itself. The three subfloor cavities (*H, H, I*) have no obvious function. The rectangular pit (*I*) need not have been dug for the placing of three posts, and the two subfloor cavities (*H, H*) were well covered and trampled on. There seems no other conclusion than that these were originally dug for some reason now unknown and were later filled, and that the house was used without them. It is possible that the same people that dug them filled them, and that a separate occupation is not a necessary postulate, but there is no evidence of similar changes from other pithouses in the Southwest.

The footprints mentioned earlier throw an amusing sidelight on the final occupation of the house. At least twelve of these prints were found on the floor between the fire pit (*K*) and the wall of the house between *D* and *F* (Fig. 3). They were made when the floor was muddy and had been allowed to dry undisturbed. Later on a series of cracks had formed over the floor of the whole northern section of the house. Neither the footprints nor the floor cracks were further worn by occupants. In the southern end of the house there were no real cracks in the floor, probably because of its different composition, which resulted from an accumulation of meal and other foodstuffs soaking into the floor with an occasional flooding. The footprints are evidently those of the last person to visit the house on or after its final abandonment. Whether this prehistoric wanderer was just leaving or was engaged in some outrageous looting, he apparently favored one foot, for there are ten prints of the right foot and only two or three of the left.

A number of problems are suggested by the nature of the site and the present interpretation of its features. The variation in pottery types as one goes up through the layers above the house shows, with the exception of one odd piece (see last note to Table I), a relatively regular evolution of techniques. It is suggested that the upper cultural layers, 5R1 and 4–5*a*, are probably close in time to Judd's Pit House 2. If I am correct in my estimate of the date of Half House, then this indicates a relatively rapid deposition of between seven and eight feet during the eighth century and, perhaps, the ninth. It should be noted that this date is later than the period 500 to 700 after Christ that Bryan assigns to his Deposition II on the basis of sherd evidence given by Bryan (4). Whether this situation would indicate that an alteration in my estimated dates is in order or merely that this part of Chaco Canyon provides a variation in Bryan's conclusions I cannot say.

In the pithouse we are faced with a number of problematical phenomena. Aside from the subfloor cavities discussed earlier (Figs. 3*HI* and 4*HI*), we have the large L-shaped lignite-filled pit with a plastered bottom (Figs. 3*F* and 4*F*; Pl. V). What possible purpose it could have served has thus far escaped everyone familiar with the site. After cleaning it out, we cut through the bottom on the possibility that something might be buried beneath it, but nothing was found.

Though we have speculated on the possible affiliations of Half House with Shabik'eshchee village, the precise relationships, both cultural and historical, remain uncertain. It would not be difficult, however, to determine them if further excavations were carried on in this section of the canyon.

In conclusion, let us return to the question of the correlation between the estimated date of the house and the sequence of pottery types. If my date for Half House, between 700 and 740 after Christ, and that usually assigned to Judd's Pit House 2, A.D. 777, are correct, it means that definite changes in pottery technique and design, namely, the application of a slip and the use of corrugation on culinary wares, took place sometime between those dates in the region of Chaco Canyon. These changes in pottery, coupled with the evident architectural differences between these two sites, reflect the beginnings of the elaboration of culture in Chaco Canyon which developed into the great pueblos of Chettro Kettle and Pueblo Bonito. Since Chaco Canyon was one of the major centers of population of the Pueblo peoples in prehistoric times and since the Southwest has always been a popular area of investigation for archaeologists, it is not a little surprising that our picture of the culture and history of this region remains as spotty as it is. The present paper is offered as a small increment to the knowledge of this important area in the hope that someday we shall at least have available all information on the excavations which have been carried out.

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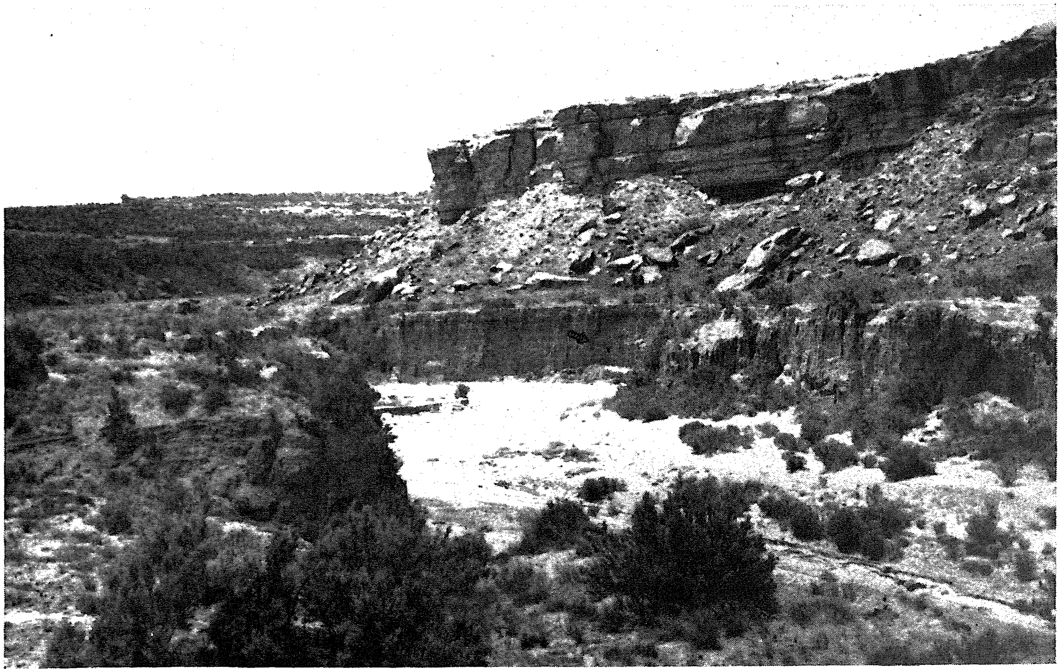
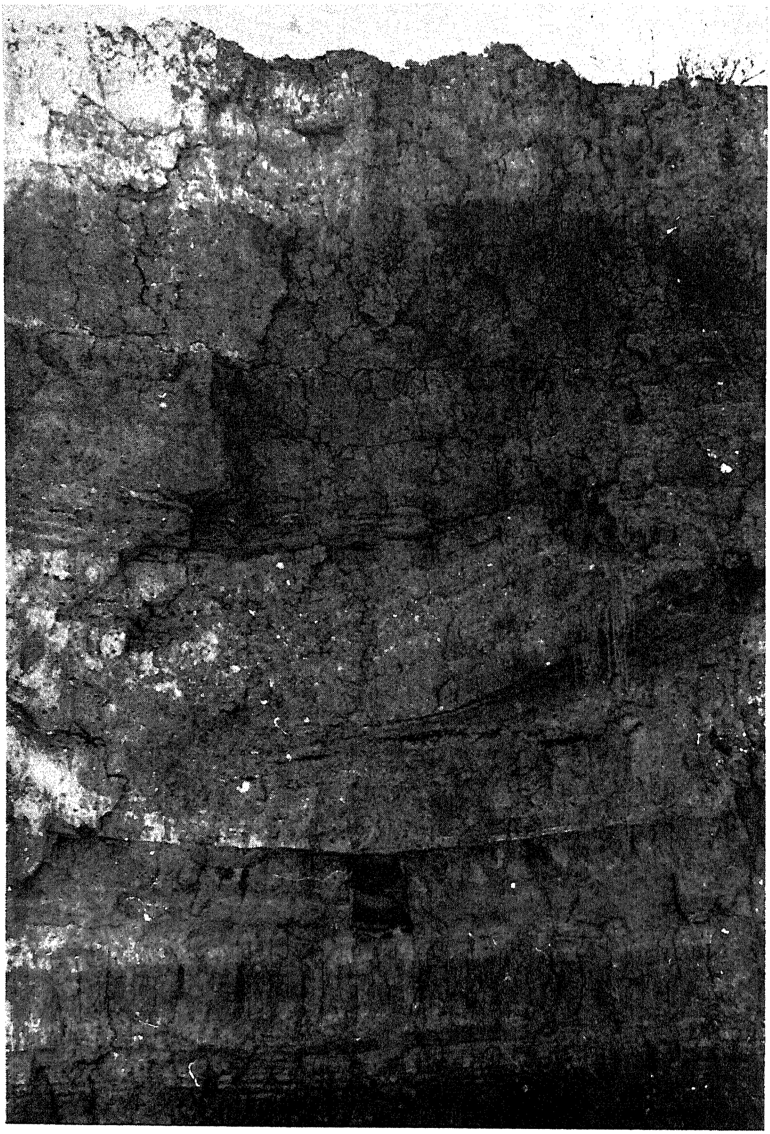
PLATES I–X

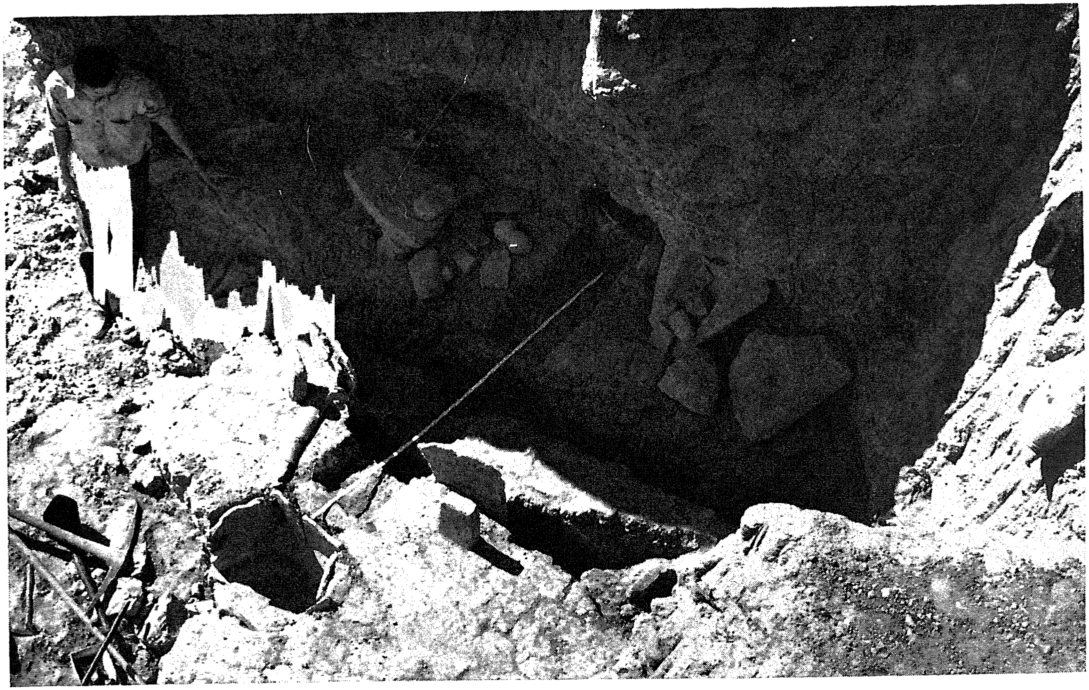


View of the site of Half House from the north prior to excavation. The arrow indicates the location of the exposed fire pit. Shabik'eshchee village is on the top of the mesa to the right

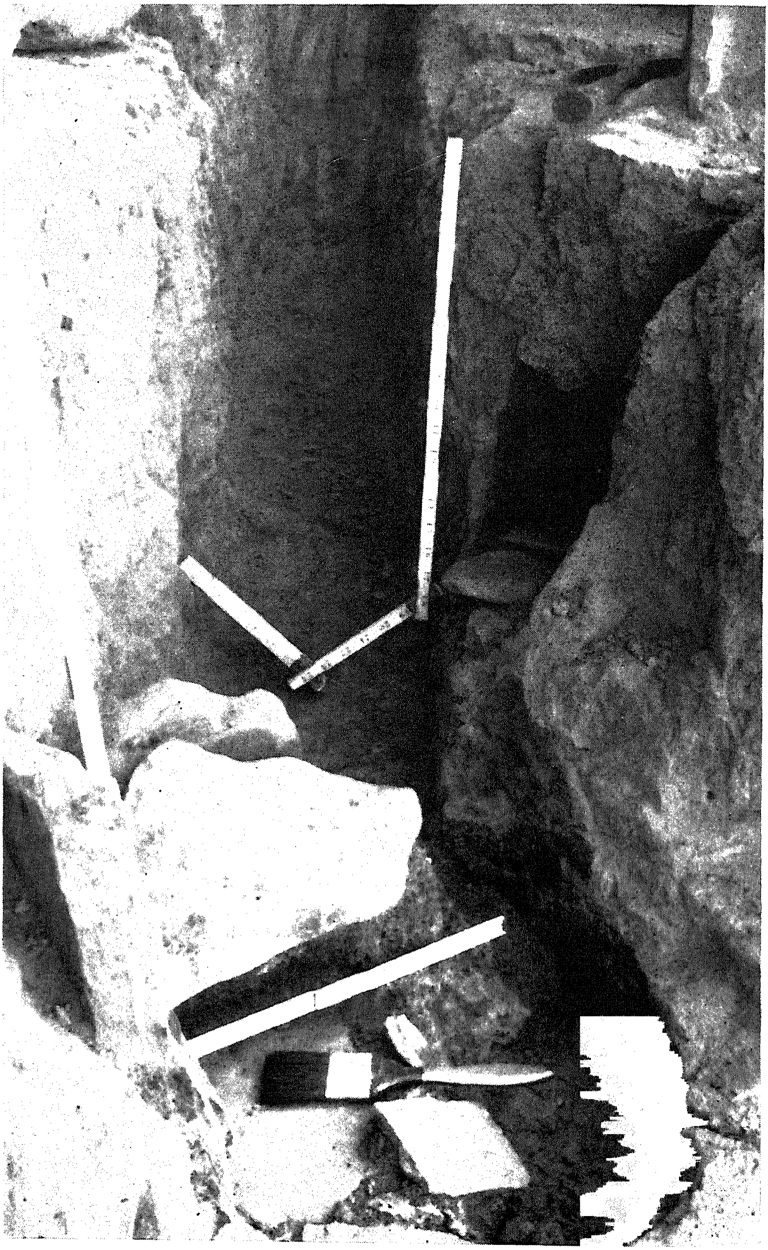


Arroyo face at site of Half House prior to the removal of the materials from the fire pit. The sand lens over the house floor is clearly discernible. Compare this view with Figure 2. (Photograph by Gordon Vivian)

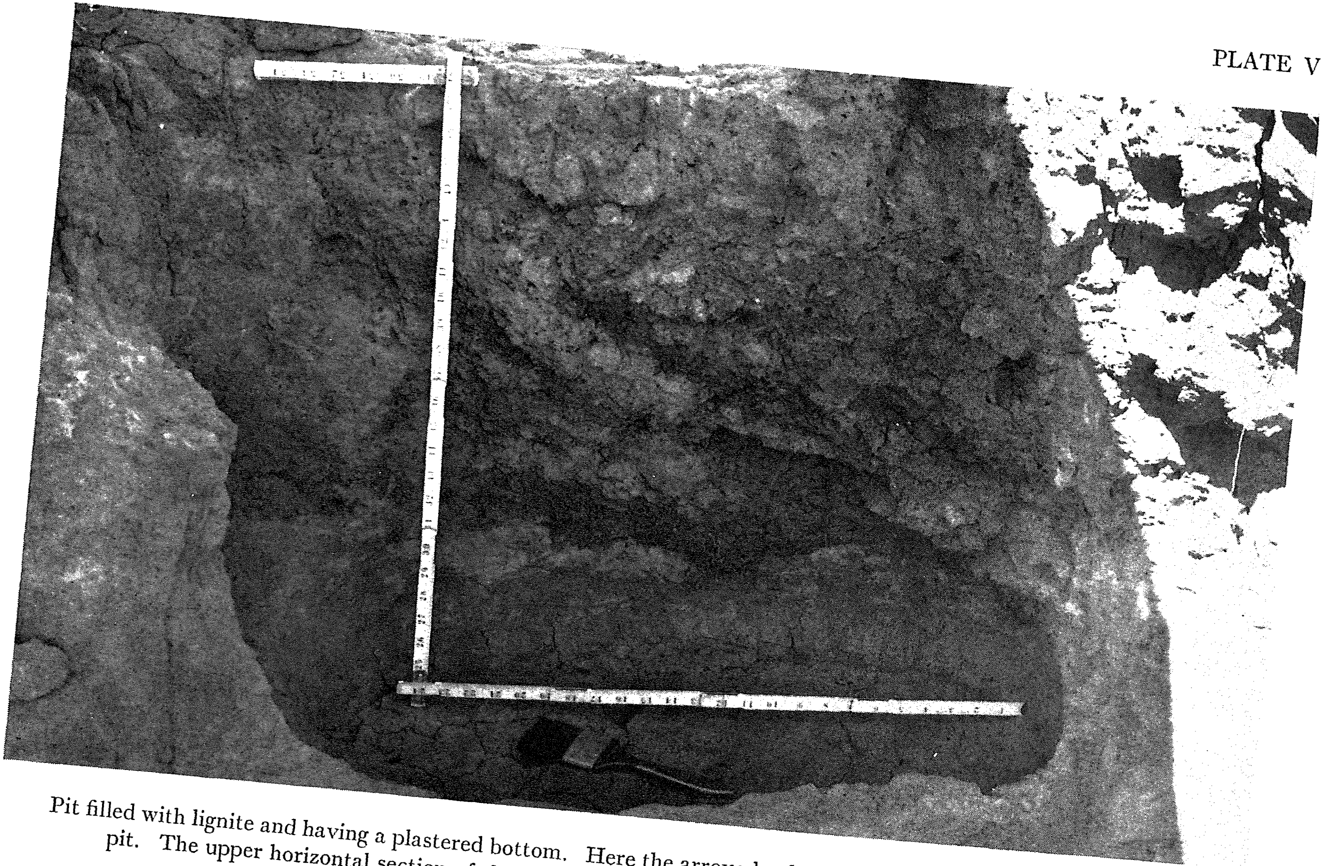
PLATE III



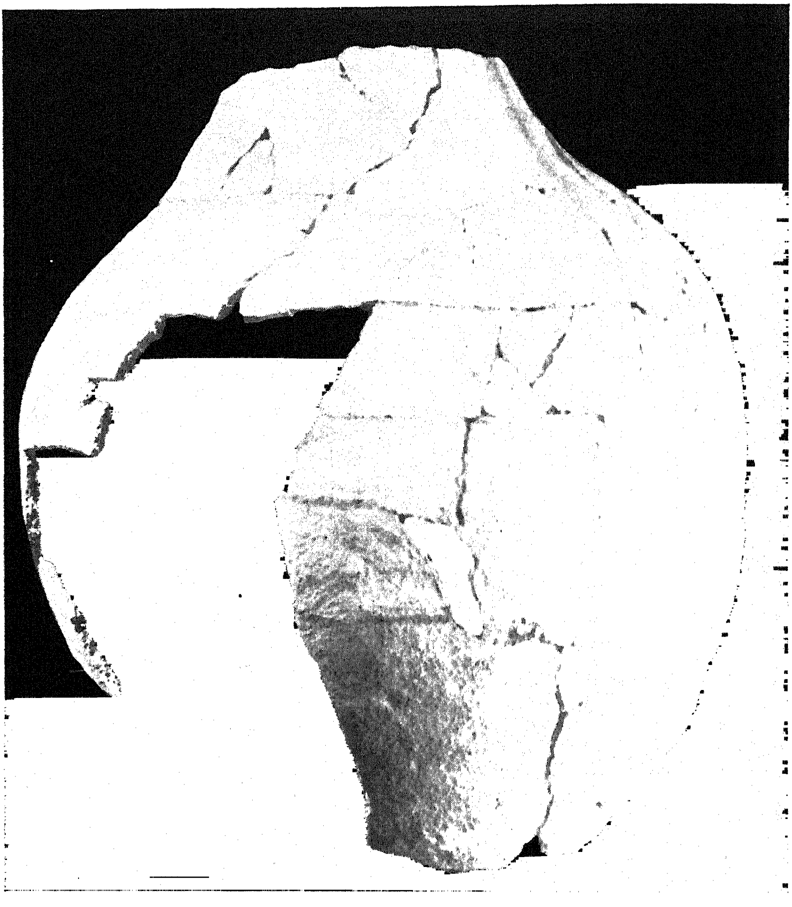
View of the northern portion of the house floor taken from the valley floor. The metates and the upright slabs are *in situ;* the smaller stones are not, but were taken from the immediate vicinity. The six-foot rule lies in a shallow test trench which is not a part of the house construction. Perpendicular to the rule is the test trench which exposed the subfloor fireplace. Compare the photograph with Figure 3. (Photograph by Boyd Wettlaufer)



Close-up of the subfloor fireplace, looking west. Just to the right of the center of the photograph is exposed the west subfloor cavity. (Photograph by Boyd Wettlaufer)

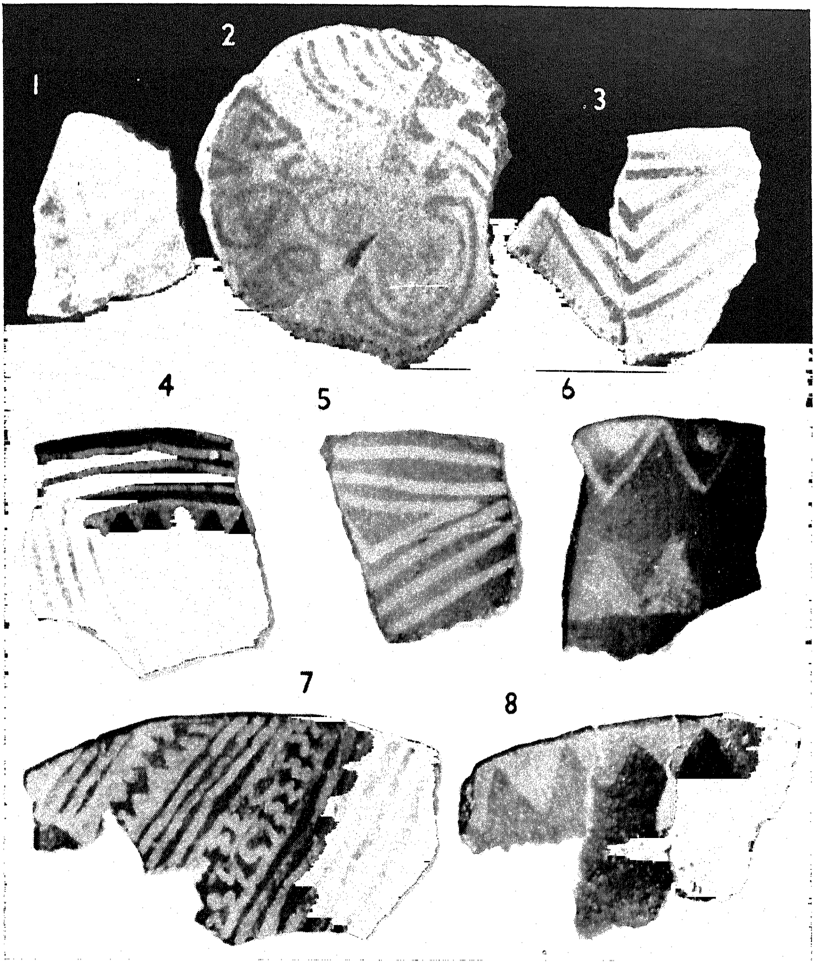


Pit filled with lignite and having a plastered bottom. Here the arroyo bank has been cut away to expose the entire pit. The upper horizontal section of the rule is at the floor level. (Photograph by Boyd Wettlaufer)



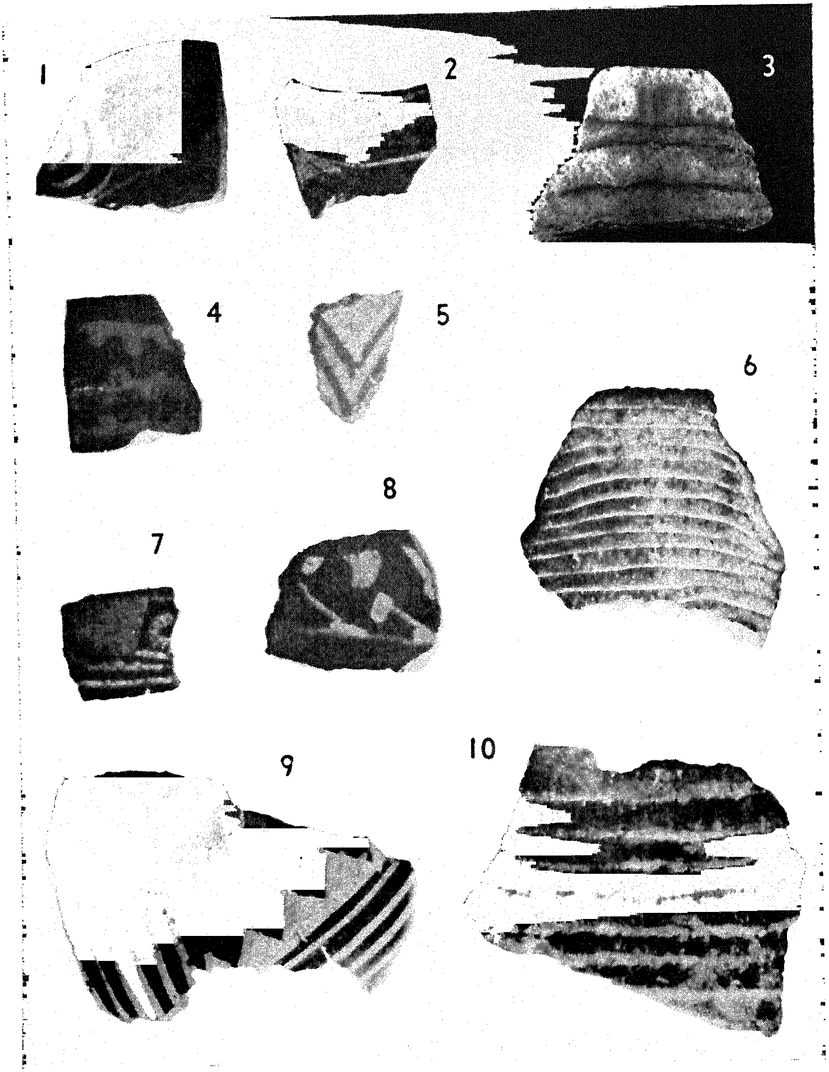
Fugitive red olla taken from the floor of the house. The maximum diameter is 37.6 cm.

PLATE VII

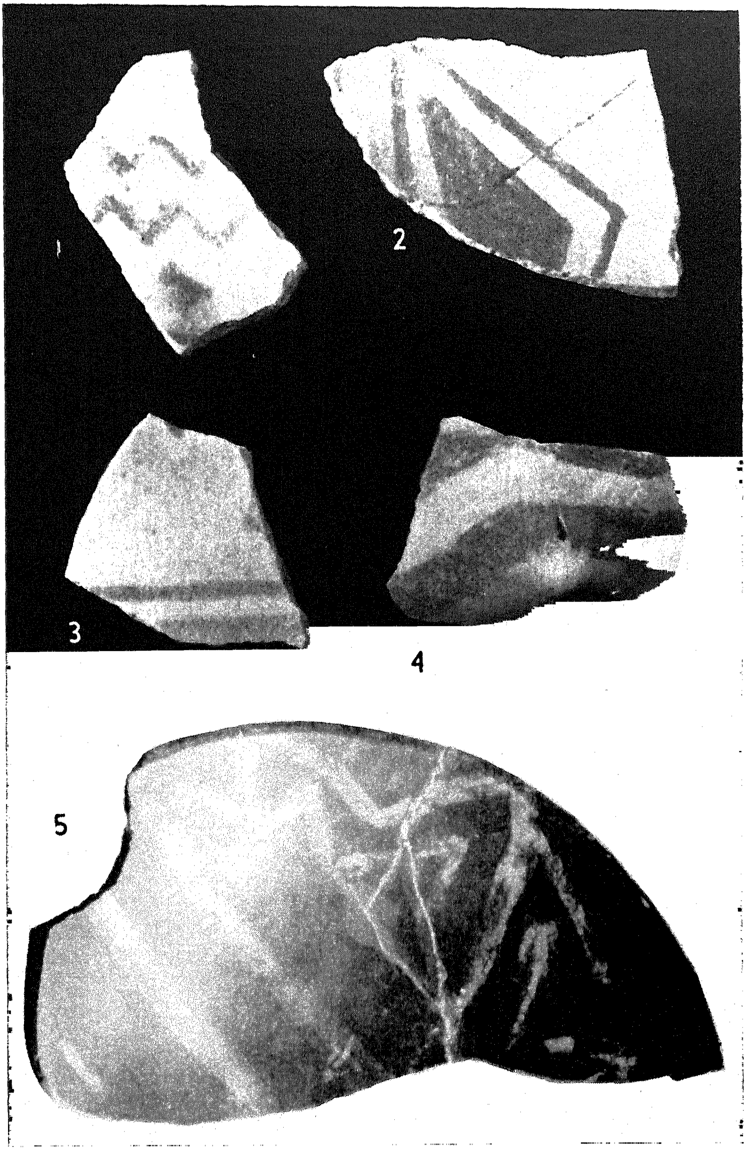


La Plata Black-on-white from the stratigraphy above Half House. Nos. 1, 3, 7, and 8 are from 5R3; No. 2 is from 5d; Nos. 4, 5, and 6 are from 5b. Scale: No. 7 is 12.7 cm. across

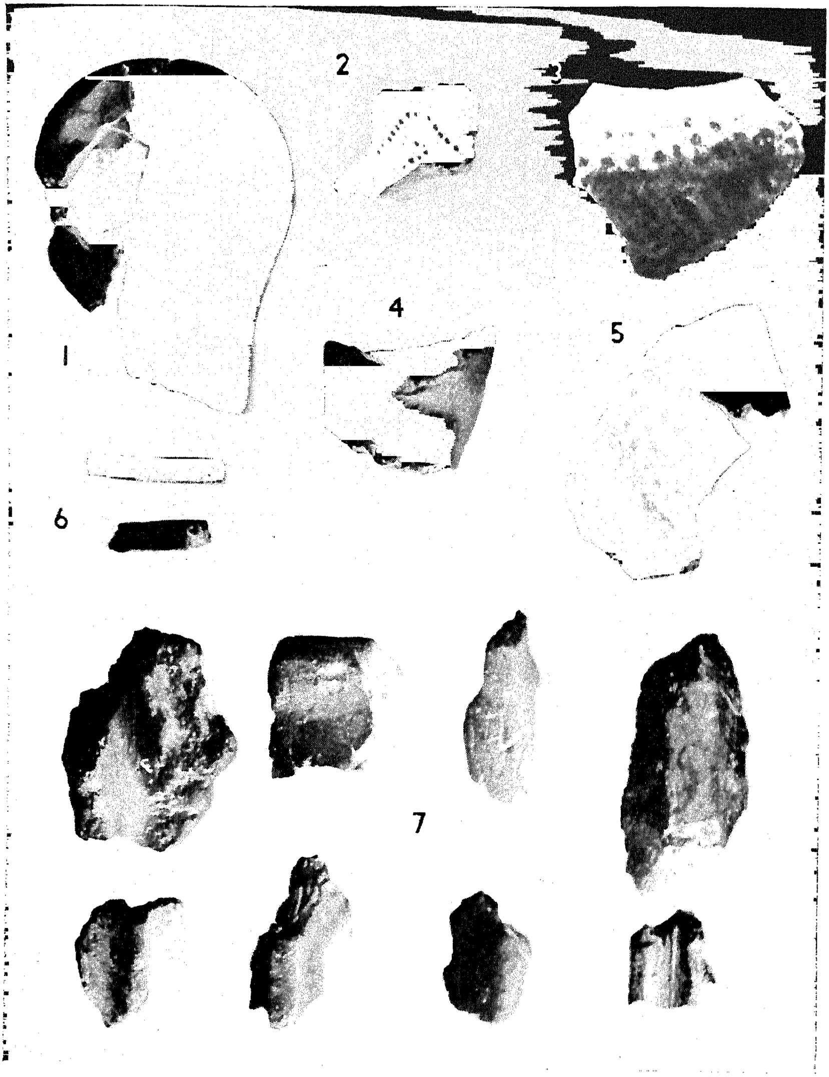
PLATE VIII



Sherds from the higher levels in the stratigraphy of the site. Kiatuthlanna Black-on-white: Nos. 1 and 2 are from 4–5*a;* No. 4 is from 3; Nos. 7 and 8 are from 5R1. Whitemound Black-on-white: No. 9 is from 5R1. Corrugated Ware: No. 3 is from 5b; No. 6 from 5R1; No. 10 from 4–5*a*. Scale: No. 6 is 10.1 cm. across



Orange ware from the Half House excavation. No. 1 is from 5*b;* No. 2 from 5R1; No. 3 from 4–5*a;* No. 4 from 5R3; No. 5 from the floor of the house. Scale: No. 2 is 8.5 cm. across



Miscellaneous artifacts. No. 1 is a plain gray scoop from layer 5*d*. No. 2 is an unbaked clay object with punctate design, from 5*d*. Nos. 3 and 5 are Lino Black-on-gray, from 5*b* and the floor level, respectively. No. 4 is a Fugitive Red effigy foot, from 5*d*. The two items of No. 6 are partially baked clay rolls from 5R1. The eight items composing No. 7 are specimens of the walling and roofing clay found in the fill immediately above the floor. Scale: diameter of No. 1, the scoop, is 7.2 cm.

GRECO-BYZANTINE VESTIGES IN *GIRART DE ROUSSILLON*

ALFRED ADLER

IN THE form in which we have it the epic known as *Girart de Roussillon* seems to have been composed during the second half of the twelfth century.[1] At the beginning and toward the end of this long narrative there are references to personages of Greco-Byzantine provenience, an emperor of Constantinople and his two daughters, one (Berte) to be the wife of Girart, one (Elissent) the wife of the king of France.[2] The initiative of both ladies plays an important rôle in the dénouement of the entire plot. This Greco-Byzantine framework seems to be one of the specific contributions of the late twelfth-century redactor.[3] My purpose here is to show that these late additions are not negligible for an understanding of the poem in its extant form,[4] and that they can be best understood if set off against the historical background of 1166 or shortly after. In view of the circumstance that a critical edition of the twelfth-century poem does not yet exist,[5] my study can be but one among many tools which a future editor may want to use.

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[1] Quotations will be given by pages (not paragraphs) from the edition by Paul Meyer, *Girart de Roussillon, chanson de geste, traduite pour la première fois* (Paris, 1884). The text of the *Vita nobilissimi comitis girardi de Rossellon* is that contained in *Girart de Rossillon,* ed. E. B. Ham (Yale University Press, 1939), pp. 375–396, an improvement over P. Meyer's readings in *Romania,* 7 (1878) : 161–235. For the date of *Girart de Roussillon* see Meyer, *op. cit.,* pp. xliv–xlvx; Joseph Bédier, *Les Légendes épiques* (Paris, 1926), II : 3; Ferdinand Lot, *Romania,* 52 (1926) : 257–295. Lot's argument (see *Annales du Midi* [1919], pp. 74–76) that the mention of Arthur de Cornuaille's battles in Burgundy came to the redactor of *Girart* from Wace's *Brut* (ed. I. Arnold [Paris, 1940], II, vs. 11616), and therefore must have been written after 1155, does not seem decisive, since the problem of the date is connected with the manner in which Arthurian traditions reached the continent. Eric S. Murrell, *'Girart de Roussillon' and the 'Tristan' Poems* (Chesterfield, 1926), adds nothing to the information about the date (cf. W. A. Nitze, *Mod. Phil.,* 25 [1927–28] : 355–357).

[2] More specific quotations are given below.

[3] Meyer, *op. cit.,* pp. xxxix, xliv.

[4] Because of their character as a later addition — they are not in the *Vita* — the references to the Greco-Byzantine world have been rather neglected. Even Albert Stimming (*Über den provenzalischen Girart von Rossillon* [Halle, 1888]), who tried to integrate the part of the narrative connected with Greek persons, eliminated names referring to the Greek orbit.

It has been said quite correctly that a feature which distinguishes the epic from the *Vita Girardi* is the references in the former to Constantinople, to the pope, and to the Orient.[6] At the court of King Charles of France the pope speaks of the emperor of Constantinople as governor of Rome (p. 2) and suzerian over the Holy See (p. 3). The French king is to help the emperor. After the marriage of Elissent and Charles they are crowned in Rome (p. 16). Toward the end of the poem the pope, himself under the temporal sway of the Greek emperor, makes all the important decisions on the French king's course of action. He even changes the king's name from Charles Martel to Charles le Chauve (pp. 300–301). Clearly the emperor of Constantinople is conceived as of the highest rank, higher than the French king, and, in temporal matters at least, higher than the pope. That such implication is not negligible for the time after the Second Crusade becomes evident from Greek, Latin, and, possibly, Old French sources.[7]

Elissent, the Greek emperor's daughter and queen of France, is superior to her husband. She herself says that she can handle the king as she pleases (p. 249), and there is evidence that her claim is justified (pp. 250, 281–282). After Girart's return from his exile the queen's initiative is paramount. "La reine chevauche, tandis que te reposes" (p. 265). Her influence is beneficial; she works for peace (pp. 273, 285). Girart submits to the king out of gratitude to the queen (pp. 296, 300).

Berta, the older daughter of the Greek emperor, who had been meant for the king (p. 8), but became the wife of Girart, is the decisive influence in the life of her husband. His moral support in the days of affliction, she advises him to interrupt his exile and asks the queen, her sister, to help him secure the forgiveness of the king (p. 246). If Girart receives any land after his exile, he gets it as the manager of Berta's dowery (p. 285). The relics of St. Mary Magdalene are found to be deposited at Vézelay. This happy event is the reward for the two sisters' goodness (p. 286). There is hardly any need to add that the founding of Vézelay and the miracles performed there in connection with the worship of St. Mary Magdalene are closely associated with Berta, and the reward, really, for Berta's saintliness.

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[5] Critical editions of this unusually difficult text have been announced by Miss W. M. Hackett (*Publ. Mod. Lang. Assn.*, 63 [1947], *Research in Progress*, No. 2820), and by René Louis (see note 65).

[6] Murrell, *op. cit.*, p. 22.

[7] See Kinnamos (ed. A. Meinecke [Bonn, 1836], p. 83) and Odon of Deuil (*De profectione Ludovici VII in orientem*, ed. and tr. Virginia Gingerick Berry [Columbia University Press, 1948], p. 76), and, if the *Pèlerinage*, in its present form, is of the time, cf. *Speculum*, 22 (1947) : 552. See also the *Epistola Manuelis ad Eugenium* quoted by Berry (*op. cit.*, p. 10). An argument in favor of the superior rank of the Greek emperor could have been drawn from the *Liber pontificalis*, ed. L. Duchesne (Paris, 1886–92), I: 496, II: 88, 300, 340. Here are references to Charlemagne's first visit in Rome (774), where he received only the honors due to the exarch, the viceroy of the Byzantine emperor. This reception remained the standard for all imperial receptions in Rome. See E. H. Kantorowicz, *Laudes regiae, a Study in Liturgical Acclamations and Mediaeval Ruler Worship* (University of California Press, 1946), p. 75, n. 33 (also quotations from the *Liber censuum*, I. 1). Since Charlemagne was canonized in 1165 through the initiative of Barbarossa and his antipope, all those against Barbarossa and in favor of Alexander III would want to remember such distinctions.

Thus, while it may be true that the beginning and the end (the Greek framework) are later additions, this Greek *broderie* has added distinctive shades to the picture of *Girart de Roussillon* as we now have it. One might go so far as to suggest that, whereas the nucleus of the plot, the struggle between Girart and his suzerain, is an issue increasingly difficult to disentangle as the narrative proceeds,[8] the Greek frame — the two women seconded by the pope, and Vézelay, a "Greek" foundation — helps to sharpen the contours. After so much wrangling and parliamentarizing between Girart and his followers and the king and his group, what is the upshot? Neither the king nor his unruly vassal is the winner. The king submits to the counsel and reproof of a pope kindly disposed toward the Greek emperor. The vassal, thanks to his "Greek" wife, has become the founder of a shrine. The circumstances of its construction have been compared with occurrences accompanying the building of St. Sophia in Constantinople.[9] The vassal remains childless. God (Vézelay) is his heir (p. 292).[10] After all the carnage is there anybody left, anything of unimpaired prestige? Yes, in addition to a "Greek" queen of France, there is "Greek" Vézelay and also a "Greek" pope.

[8] In the beginning of the struggle Girart seems right, the king wrong. Then Girart himself becomes cruel. However, the long discussion in the camps of Girart and of the king and the disagreements within these camps in regard to the advisable policy create the impression that right and wrong are difficult to disentangle. See Meyer, *op. cit.*, pp. 21–26, 45–47, 117–123, 132–145, 174, *et passim.*

[9] Pp. 306–308. As will be shown below (p. 305), the references to St. Sophia toward the end of the poem help to recall the Byzantine origin of Berta. Although the central portions of the poems have nothing to do with them, the Byzantine beginnings are remembered at the end (pp. 300–305), where, as in the beginning, the pope is prominent. After so many years had passed by, Elissent (p. 260) and Berta (p. 305) are still as young and attractive as in the "Greek" beginning.

[10] Girart goes to bury his son, saying: "Puis que Dieu n'a pas voulu laisser vivre notre fils, faisons de lui [Dieu], s'il lui plaît, notre héritier," shortly before Berta goes to Vézelay to found a *moutier* in honor of St. Mary Magdalene (p. 302).

That Vézelay is a factor in the legend of Girart de Roussillon need not be elaborated.[11] The question to raise here is what was the bearing on Vézelay of Constantinople. The obvious starting point for conjectures would be the Second Crusade, preached by St. Bernard in Vézelay. Nothing friendly about Constantinople can be reported as the outcome of this disastrous failure which, in the words of the same St. Bernard, was so shocking an experience that Christians were fortunate if they were not scandalized.[12] An attempt to connect our *chanson* with the Second Crusade remains in the realm of loose generalities.[13] The picture is very different for the time after 1160. To evaluate the events in the sixties it must be remembered that Vézelay was one of the monastic foundations under the jurisdiction of the pope only. Though temporarily subjected to the abbot of Cluny, Vézelay, from the earlier sixties on, insisted very strongly on the abbey's ancient status, its subordination to the pope only. Hugues de Poitiers, the chronicler of Vézelay from 1140 to 1167, abounds in repetitions on this point.[14] His reasons for such emphasis and, in fact, the main purpose of his chronicle were to explain Vézelay's conflict with the counts of Nevers, who threatened to disregard the time-honored status of the abbey.

The plight of Vézelay was fairly desperate, especially since Pope Alexander III was too handicapped by the problems of the schism to protect *his* abbey effectively. This pope had fled from Rome to France in 1162. The abbot of Vézelay had been the first to receive the legates of the pope previous to the latter's arrival. In Maguelonne the abbot of Vézelay was among the first to greet the pope.[15] One of the first decisions made by Alexander III on French soil was to declare Vézelay freed from its obligations to Cluny, then schismatic.[16] In France Alexander III made Sens his headquarters,[17] rather near to Vézelay, and kept in close contact with the affairs of the perhaps oversolicitous abbot,[18] who was among those most keenly interested in the increase and consolidation of papal power. Anything that would forward or justify the hope for the increase of papal power during the schism would be welcomed by Vézelay.

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[11] In addition to the work of Paul Meyer and the decisive discussion of Joseph Bédier there are the studies of R. Louis (*Romania,* 58 [1932] : 505–519; *Romania,* 62 [1936], 173–195), the latter showing connections between details about Valbeton in the *Chanson* and in the actual vicinity of Vézelay.

[12] For a picture of Constantinople during the Second Crusade as seen by Odon of Deuil see Berry, *op. cit.,* pp. 59, 69, 99. For St. Bernard's mood after the Crusade see *Cambridge Med. Hist.,* 5 (1926) : 307.

[13] Murrell, *op. cit.,* pp. 22–25.

[14] *Histoire du monastère de Vézelai,* par Hugues de Poitiers in *Collection des Mémoires relatifs à l'histoire de France* (transl. F. P. Gn. Guizot), pp. 101, 103, 104, 106, 133, 134, 135, 136, 137, 139, 152, 159, 160, 208, 209, 212, 250, 252, *et passim.*

[15] Poitiers, Hugues de, *op. cit.,* pp. 203–204.

[16] *Ibid.,* p. 214.

[17] *Ibid.,* p. 231.

[18] See notes 15–17.

Among such hopes there was the development of a policy looking toward a rapprochement between Manuel I Comnenus, emperor of Constantinople, and Alexander III. In July, 1163, two envoys of Manuel came to France, one of whom conferred with the pope and with Louis VII.[19] In 1165 the pope returned to Italy.[20] Vézelay continued to be very much interested in the papal moves, especially since the years 1165 and 1166 were quite critical for the conflict with the count of Nevers.[21] In 1166 Manuel's envoys were in Rome to push the negotiations concerning the reunion of the Greek Church with the Roman. As a compensation, Manuel asked for the imperial crown in a united Empire of East and West.[22] Partly religious and partly political, the negotiations concerning the reunion had been carried on for some time, and had been among the objectives of the interview in France mentioned above.[23]

The project did not materialize. Though favorably disposed, Alexander III had to consider the opposition of Sicily to Greek overlordship,[24] as well as the descent of the German emperor into Italy toward the end of 1166. Since it was primarily directed against Barbarossa (supporter of the antipope), the Greek project had to be dropped when Barbarossa began to reassert influence in Italian affairs. As for Vézelay, in order to appraise the significance reasonably assumed to have been ascribed to the Greek project, one should compare the historical reality at the end of 1166 with the dream picture a man in the orbit of Vézelay might have created at the same time. Such a comparison may help to decide whether or not our *chanson* in its twelfth-century form reflects that dream.

At the end of 1166 Louis VII had settled the conflict of Vézelay with the count of Nevers, and had reconfirmed the old privileges of the papal abbey.[25] The need for recourse to the king had been resented somewhat as a humiliation. At an earlier date the abbot of Vézelay had gone to St-Denis for help, but, asked to wait for the king's decision, he had withdrawn his petition — *while the church was not yet completely dead.*[26] In 1165 the conflict with Nevers had reached such a pitch that the monks were driven into exile. Pleading in the proud royal abbey of St-Denis, they seem poor and helpless by contrast.[27] Not always loyal to their abbot, the tenants of Vézelay, the *exécrable commune,* had made common cause with Nevers.[28] Cluny was hostile, schismatic, and therefore closer to Barbarossa, who was as much to be feared in this border region as the protection of the French king was humiliatingly needed. How different could matters have been for Vézelay if, as in the good old days, the reality might be the achievement of what Vézelay considered its rightful claims! There would have been a feudal lord, not hostile like the count of Nevers, but devoted like Girart the founder, a powerful bulwark against extension of royal prerogatives. This feudal protector, though he might be redoubtable himself, would die childless,[29] leaving a powerfully endowed Vézelay in a world where the pope dictates even to the king. Shortly after 1166 the dreaming of such a dream would be plausible, especially as it had almost come true. With the emperor of Constantinople as temporal overlord in the West and as supporter of the pope, the prestige of other Western secular rulers would have waned. The pope would have been strong enough to overrule even the king of France, who in the "dream" (the *Chanson*) might easily assume the features of a "tyrant" such as Barbarossa. With no friends close by — Nevers, Cluny, the German emperor and even the French royal protector being "distant" for one reason or another — is it not understandable that a *clerc* in the orbit of Vézelay, and one who may have traveled to Byzantium,[30] could envision a powerful friendship in faraway Constantinople, yet not so far that the pope had not made it seem momentarily rather near?

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[19] *Recueil des Historiens des Gaules,* 16 : 58. Louis VII had not been very interested, but Raimond de Toulouse had prevailed upon him to send an embassy to Constantinople (*Recueil,* 16 : 56). Alexander III had written to the king recommending the Greek envoys and advising that the letter be written to Manuel (*Recueil,* 15 : 803–807, 814). In 1165 a letter had been received in Paris; cf. F. Chalandon, *Histoire de la domination normande en Italie et en Sicile* (Paris, 1907), II : 300.

[20] *Ibid.,* II : 302.

[21] Poitiers, Hugues de, *op. cit.,* p. 314.

[22] *Liber pontificalis,* ed. Duchesne, II:415. See also Ughelle-Coleti, *Italia Sacra* (Venice, 1717–22), VIII, 1 : 119, 358, and Chalandon, *op. cit.,* II : 359.

[23] Norden, W., *Pabsttum und Byzanz* (Berlin, 1903), p. 93; Chalandon, *op. cit.,* II : 357, 358.

[24] Chalandon, *op. cit.,* II, 359. See also F. Chalandon, *Jean II Comnène et Manuel I Comnène* (Paris, 1913), p. 565; Kinnamos (*Corp. Script. Hist. Byz.,* p. 262); Louis Bréhier in *Cambridge Med. Hist.,* 4 (1923) : 600; H. Reuter, *Geschichte Alexanders des dritten und der Kirche seiner Zeit* (Leipzig, 1860–64), II : 247.

Justified in view of the historical background, the conception of Constantinople as a wishful mirage created from very real wants must be substantiated in more detail. As said before,[31] Alexander III had made

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[25] Poitiers, Hugues de, *op. cit.*, p. 319.
[26] *Ibid.*, p. 162.
[27] *Ibid.*, p. 305.
[28] *Ibid.*, p. 169.
[29] See note 10.
[30] Meyer, *op. cit.*, p. xlv. For a tradition about Manuel's love for the French see Robert of Clari, *La Conquête de Constantinople*, ed. Ph. Lauer (Paris, 1924), pp. 16–18.
[31] See note 16.

Sens his headquarters during his stay in France. In the *Chanson* the pope leaves Sens to come to the tent of the king, there to decide on the final reconciliation (p. 298). This may be a coincidence. In the beginning the important episode of the exchanging of brides — Berta being given to Girart, Elissent to the king — takes place in Benevento (pp. 12–13). There the pope warns Charles Martel that he should keep Berta, as had been solemnly agreed in the church of St. Sophia in Constantinople. Historically, Benevento was a significant name since 1158, when the peace was concluded between Constantinople and Sicily. This treaty ended the hopes of the pope for a reconciliation with Barbarossa,[32] and henceforth he had to rely on two main supporters, the king of Sicily and the *basileus*.[33] The archbishop of Benevento was one of the earlier negotiators in Constantinople in favor of the reunion.[34] The relationships among France, Southern Italy, and the papacy were especially good between 1163 and 1165.[35] In 1165 the pope returned to Rome via the south of Italy.[36] In a letter of December, 1167 (referring to earlier events), John of Salisbury writes to bishop John of Poitiers: "Dominus papa, receptis nuntiis qui Constantinopolim profecti fuerant cum muneribus et honore, . . . moram [facit] Beneventi."[37] Here we have the picture of the pope (coming from France) in Benevento favorably disposed toward Constantinople at a time when Barbarossa was the antagonist. In the *Chanson* we have the pope (coming from France) in Benevento favorable to Constantinople. The antagonist is Charles Martel, French, but an "emperor."

Historically, the first count of Nevers was Landri de Nevers,[38] who is often mentioned in the *Chanson* as an advocate of peace between Girart and the king.[39] In the *Chanson* the possessions of Girart are often, though not consistently, called allodial.[40] Apparently the author had vague notions about legal differences between *alleu* and *fief*. One might ask if this had something to do with the fact that the core of the conflict between Vézelay and the counts of Nevers was the recognition of Vézelay as an immune estate. Hugues de Poitiers does not seem much clearer about the difference, for in spite of his many assertions that Vézelay was immune, subject to the pope only,[41] he admits that the abbot rendered homage on various occasions.[42]

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[32] Chalandon, *Domination normande,* II: 254–255. [33] *Ibid.,* p. 356.

[34] *Ibid.,* p. 358. [35] *Ibid.,* p. 301. [36] *Ibid.,* p. 302.

[37] Epistola CCXXVIII in *Patrologia Latina,* 119, col. 259.

[38] Poitiers, Hugues de, *op. cit.,* p. 207.

[39] Pp. 47, 73, 100, 135–136. The question is difficult because a Landri is also an epic figure referred to otherwise. See F. Lot, *Romania,* 32 (1903) : 1–5.

[40] Pp. 14, 15, 17, 19, 23, 25, 26, 62, but not so on pp. 99, 100, 116, 236, 312.

Less episodic and more rewarding is a study of our *Chanson* with reference to St-Denis. In the beginning, when the French delegation comes to Constantinople to ask that the princesses be promised to the king and Girart, the French guests are entertained with *jeux étranges.* Magicians conjure rain and storm and other frightening signs, and the French are properly scared. However, "c'étaient de grands et sages personnages," who did not wish to continue with such amusements. A comparison with a similar situation in the *Pèlerinage Charlemagne* shows Charles and his peers in Constantinople. The following extracts are significant: "Devers les Porz de mer oit un vent venir Bruiant vint al palais . . ."; "Si l'at fait *esmoveir"; "*Molt fut granz li *orages,* la neis et li gresilz . . ."; "Molt fut grié li orages. . . ." Not so wise as the delegation in *Girart de Roussillon,* the companions of Charlemagne behave rather foolishly: "Et covrirent lor chiés . . . ." "Et dist li uns a l'altre. 'Mal somes entrepris,' " so that Hugon, the Greek emperor, has to reassure them "Ne vos desconfortez."[43] In the *Pèlerinage* Hugon has a *blanche barbe* (vs. 660). In *Girart* the Greek emperor has *la tête chenue* (p. 10). He has relics of saints brought before the French (p. 8). Hugon "a fait les reliques aporter devant lui" (vs. 667). In *Girart* the *pierres précieuses* (p. 10) in the emperor's palace recall the *escuële . . . a pieres precïels* (vss. 178–179) and, of course, the *carboncles* (vs. 442) in Hugon's palace. In two otherwise comparable situations the main difference is the behavior of the French, foolish bewilderment in the *Pèlerinage,* dignified sense of superiority over impressive tricks in *Girart.* If, as some believe,[44] the *Pèlerinage* in its present form has some bearing on the situation in St-Denis shortly after the Second Crusade, does it not seem as if Vézelay had been teaching a lesson to St-Denis?

Regardless of whether or not the *Pélerinage* refers to so late a date as 1150, the fame of St-Denis as the center of radiation for early Gothic art and its prestige as the nucleus of a growing kingdom must have been felt in Vézelay, and, inasmuch as the latter was a vestige of feudal decentralized France, this prestige must have been resented. In view of this, the incidents told about the foundation of Vézelay can be taken as another lesson taught to St-Denis. All the more so because both abbey churches, St-Denis as well as Vézelay, had "Greek" affiliations. For the cultural ties of Suger and St-Denis with Dionysius the Areopagite and, hence, with the Greek world, the recent findings of Professors Crosby and Panofsky should be consulted.[45] Whereas St-Denis was the work of Suger, and therefore identified with the name of the kings (of St-Denis), Vézelay in the *Chanson* is primarily the work of a vassal's pious wife. The story told by Badilo, *who had seen St. Sophia* (p. 308), of the poor woman whose small contribution to the construction of St. Sophia had been rated higher than the riches contributed by the Greek emperor, acquires its full weight if taken as the expression of an attitude against St-Denis.[46] Contrasted with the royal pomp of St-Denis, there is Vézelay, the contribution of a "poor" woman, the wife, not of a king, but of an impoverished vassal. Yet for all that, Vézelay is not less "Greek" than St-Denis, for Berta is "Greek."

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[41] See note 14. [42] Pp. 138, 152.

[43] *Karls des Grossen Reise nach Jerusalem und Constantinopel,* ed. E. Koschwitz and G. Thurau (Leipzig, 1923), vss. 369, 370, 371, 378, 384, 389, 390, 395. Italics in quotations are mine.

[44] Heinermann, T., *Zeitschrift für Rom. Phil.,* 56 (1936) : 550; R. C. Bates, *Yale Romanic Studies,* 18 (1941) : 1–47; A. Adler, *Speculum,* 22 (1947) : 550–561.

The peculiarity in our *Chanson* of calling the French king Charles Martel, and then at the end changing his name to Charles le Chauve, may also assume a new significance with reference to St-Denis. Charles Martel was a black sheep in the books of the abbey. Because of the constructions there in the late forties special attention must be given to an old tradition to the effect that Pepin had commanded that, because of the sins of his father Charles Martel, he should be buried outside at the entrance, face downward and not recumbent.[47] On the other hand, Charles the Bald, an important figure in the thinking of Suger and, among other things, sponsor of the Latin translations of the Areopagite,[48] had been given the honor of having the offices of his anniversary celebrated, more solemnly than usual (before 1141), every month on the day before the

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[45] Crosby, S. McK., *The Abbey of St-Denis* (New Haven, 1942), Vol. I: *Abbot Suger on the Abbey Church of St-Denis and Its Art Treasures,* ed., transl., annot. E. Panofsky (Princeton, 1946).

[46] The story itself is not necessarily Greek. It may be an amplification of St. Luke, 21 : 1–4. The setting is Greek. For Badilo the best recent references are found in *Girart de Rossilon,* ed. E. B. Ham (Yale University Press, 1939), p. 99. Mary Magdalene is a saint of the Greek calendar. The Greeks celebrate the day of Magdalene the penitent sinner on March 21 (in some places on March 19), the day of the sister of Lazarus is celebrated on March 18, the day of Mary Magdalene celebrated by the Greek as well as the Roman church is July 22. Cf. P. Ketter, *Die Magdalenenfrage* (Trier, 1929), p. 44.

[47] "Pipinus imperator extra in introitu valvarum pro peccatis patris sui Karoli Martelli prostratum se sepeliri, non supinum, fecerat." Cf. Suger, *De Administratione,* in Panofsky, *op. cit.,* p. 44.

[48] Théry, G., *Études dionysiennes* (Paris, 1932), I:63.

Nones.[49] Now Charles the Bald was associated with notions of byzantinism.[50] Yet he had also been the ruler weak enough to grant, somewhat against his will, the exemption of Pothières and Vézelay, complying with the wishes of a feudal lord, Girard.[51] From the point of view of a rivalry between Vézelay and St-Denis around 1166 the choice of the ruler in a *chanson* written in the orbit of Vézelay would seem more understandable in the light of the foregoing information. Charles Martel, an embarrassment for St-Denis, would seem the person most fit to represent the kingship for people who did not yet endorse the principle of centralized power as against particularistic tendencies. Toward the end, and in view of the circumstance that some kind of reconciliation must seem desirable in any Christian setting, the king (through papal initiative) is transformed into Charles le Chauvre, i.e. a ruler weak enough to bargain with a vassal who was strong enough to be appreciated in the royal abbey, and "Greek" enough for the purposes of Vézelay to balance any tangible effect of his "Greek" marriage upon St-Denis.

Furthermore, the epic tradition about Berta seems to assume outlines easily understood as a counterpart to the Berta traditions as we know them from St-Denis. For the restitution of this parallel the Greek elements in *Girart* are all important.

In St-Denis, Adenet le Roi has found his *matière* for *Berte aus grans piès*. According to this well-known version, Berte has been exchanged with Aliste, her servant girl, who looks very much like the princess herself and takes her place as Pepin's spouse. Berte is, of course, the legitimate queen. The king is not responsible for the maneuver. Berte's native land is Hungary. Robbed of her rightful place as queen of France, she roams in the woods, receives shelter, and turns out to be an expert in the art of weaving. Found by Pepin, she becomes the mother of Charlemagne. A monastery, Valberte, is founded in her name.[52] According to a sketchier version from St-Denis, transmitted in *Anseÿs de*

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[49] Suger, *Ordinatio,* in Panofsky, *op. cit.*, p. 130.

[50] Kleinclausz, A., *L'Empire carolingien* (Paris, 1902), pp. 393, 438–440. On the *Graecus habitus* of Charles the Bald see *Annales Bertiniani,* ed. G. Waitz (*Script. Rer. Germ.*, Hannover, 1883), p. 131. On "byzantinizing" songs for Charles the Bald see Kantorowicz (as cited in note 7), pp. 73–74.

[51] *Historia Franconum Senonensis,* ed. G. Waitz (*Mon. Germ. Script.*, 9:366 and *Mon. Germ. Script.*, 8 : 608), and M. Chaume, *Les Origines du duché de Bourgogne* (Dijon, 1925), I: 248. Details about Charles's reluctance in making concessions to monasteries are found in K. Voigt, *Die Karolingische Klosterpolitik* (Stuttgart, 1917), pp. 34–36, 38–40, 86, 171, 194, 198.

[52] *Adenet le Roi's Berte aus grans piès,* ed. U. T. Holmes, Jr. (Chapel Hill, 1946), vss. 197, 403, 552, 1380, 3172, 1125.

Mes, Berte is a Greek princess, has to be rebaptized in St-Denis before she may marry Pepin, and her first son is not Charlemagne but Charles le Chauve.[53] Godfrey of Viterbo, whose information about epic *matières* has been made the subject of a recent study,[54] knows of a tradition that Pepin's Berte was Greek.[55]

Whereas in St-Denis the Greek affiliation of Berte seems to be less emphasized than her connection with Hungary, quite the contrary is true for Berta in *Girart de Roussillon.* She, too, has Hungarian relatives (pp. 230–231), yet her Byzantine origin is made abundantly clear, and is even given the approval of the pope, who raises no questions about her orthodoxy. She, too, is being exchanged. However, though she should have been queen (p. 80), her sister (not a servant girl) takes her place. The king (Charles Martel) is responsible for reshuffling the brides. Berta, though made the wife of a vassal, is of a moral standing equal to if not higher than that of the queen. Both Greek princesses are and remain highly respectable. In exile Berta knows misery like her namesake in St-Denis. She turns out to be expert in the art of dressmaking. She is not the mother but the sister-in-law of Charles le Chauve (p. 234, formerly Charles Martel). A monastery is founded by her — near a place called Valbeton. Like Berte in St-Denis, she is a model of saintliness.

Points of comparison are not lacking. One main difference between the two versions is the treatment of the Greek factor, suppressed in St-Denis, highly developed in Vézelay. Reasons for this difference seem at hand. St-Denis was identified with the idea of a strong kingship. For the king of France, who was the "vassal" of St-Denis,[56] the question of superiority had resolved itself into a choice between his "suzerain" and Constantinople. The answer was obvious. When St-Denis was gaining in prestige, Vézelay was once more, one last time perhaps, asserting its position as mediator between king and vassal, but dependent only on the pope, who hoped to increase his power through the temporal overlordship of the *basileus.* Thus, while the *Pèlerinage* gave the king of St-Denis a stature higher than that of the Greek Hugon, in Vézelay, Girart de Roussillon, a vassal only, had a wife who should have been the queen. Mediation between king and vassal and of a sort to weaken both was in the best Cluniac tradition; it was in the background of Vézelay. Cluny had seen its peak when its abbot *mediated,* in Canossa, between the pope and the German emperor. In 1166 a flicker of the old claims seemed to be rekindling when Thomas Becket, the last of the great Gregorians, fulminated against Henry II — in Vézelay.[57] However, times had changed. The pope was not able to do much for Thomas Becket and, for a while, the last hope of Gregorianism seemed anchored in Constantinople.

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[53] *Anseÿs de Mes,* ed. Hermann J. Green (Paris, 1939), vss. 14541–14550.

[54] Meyer, L., *Les Légendes des matières de Rome, de France et de Bretagne dans le 'Panthéon' de Godefroi de Viterbe* (Paris, 1933).

[55] Memmer, A., *Die altfranzösische Bertasage und das Volksmärchen* (Halle [Saale], 1935), pp. 119–162.

[56] Panofsky, *op. cit.,* pp. 232–233.

It is significant that both in St-Denis (*Anseÿs de Mes*) and in Vézelay (*Girart*) there is some tendency to slide Charlemagne out of the tradition. In *Anseÿs,* Pepin's Berte becomes the mother of Charles le Chauve. In *Girart,* Charles Martel turns into Charles le Chauve, has a son Pepin, and proves to be a grandson of Charles Martel (p. 300). The skipping of Charlemagne cannot be an accident. Indeed, the author of the fourteenth-century *Girart de Rossillon* is quite stern about the liberties taken by his twelfth-century predecessor.[58] Now 1166, the year when Charlemagne had been canonized in the schismatic camp,[59] both St-Denis and Vézelay must have felt uncomfortable about him. However, while St-Denis had to soft-pedal its former glorification of the "schismatic saint," in the world of Vézelay Charlemagne was *a fortiori* an embarrassment from the outset; for in the world of powers divided between king and vassal Charlemagne "apostolica promissione fretus" was out of place.[60]

It has been assumed that the *remanieur* of our *Chanson* was an educated man.[61] To show that his use of the Greek embroidery in his poem served the ends of Vézelay after 1166 has been the purpose of this study. Whatever may have been the relevance of his connections with Provençal circles,[62] his use of a language somewhat strange to the ears of an audience in Vézelay is not irreconcilable with his tendencies. In Vézelay, where the supporters of the abbey were far away at the time,[63] it might even be appropriate to sing of Constantinople in strains that suggested distance.[64] For his embroidery the judicious *remanieur* undoubtedly utilized an older form of the epic. It may well be that Ferdinand Lot was right in assuming that this older form was not necessarily connected with Vézelay.[65] Any attempt, however, to trace the roots of the Girard legend back to Charles the Bald leads into a world where Greco-Byzantine concerns were as much alive as in the days of Alexander III.[66]

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[57] *Cambridge Med. Hist.,* 5 (1926) : 562.

[58] *Girart de Rossillon,* ed. Ham, vss. 78–88.

[59] *Cambridge Med. Hist.,* 5 (1926) : 394.

[60] *Historia Karoli Magni et Rotholandi ou Chronique du Pseudo-Turpin,* ed. C. Meredith-Jones (Paris, 1936), pp. vii–viii and 93. For the significance of the Pseudo-Turpin, and its possible rejection by historians of St-Denis, cf. R. N. Walpole, *Philip Mouskés and the Pseudo-Turpin Chronicle* (University of California Press, 1947), pp. 383–390 (especially p. 387). For the tendency to minimize the glory of the house of France for the benefit of Constantinople see also the plot in *Doon de la Roche,* ed. P. Meyer and G. Huet (Paris, 1921). Curiously enough, the son of Doon is Landri, who heaps scorn on Pepin and is crowned emperor of Constantinople.

[61] Meyer, *op. cit.,* p. xlvi; Lot, *Romania,* 52 (1926) : 261, 285.

[62] The claims on Burgundy of the dukes of Aquitaine seem a very doubtful link, in spite of the suggestions of E. Monaci, *Archivum Romanicum,* 1 (1917) : 500–501, and Murrell, *op. cit.,* pp. 24–25. (The document referred to by Monaci is in A. Richard, *Histoire des comtes de Poitou* [Paris, 1903], II: 487–492.) W. A. Nitze, *Mod. Phil.,* 25 (1927–28) : 355–357, puts considerable weight on the Provençal connections of our version of *Girart.* The question requires separate study. It would have to

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proceed from showing how the tradition about Girart, a regent in the Provence, affected Vézelay and Burgundy. In the event that Provençal connections can be more firmly established, one would have to explain the attitude of the Gascons who, in the *Chanson* (p. 174), desert from Girart and go over to the king.

[63] See text associated with index number 30.

[64] A study of the language of *Girart de Roussillon* is announced by Lars Kjellman (*Publ. Mod. Lang. Assn.*, 163 [1947], *Research in Progress*, No. 2821). To Professor Edward B. Ham, whose aid in improving this article has been most generous — and this is not the first occasion for me to express my gratitude for his kindness — I owe this comment: "It would help to know the dialect of the lost original. The language of the extant *G Ross* is not so far removed from the Vézelay region as to preclude authorship by someone who had frequented the abbey. The *Ch Girart* is very limitrophe, as between Burgundian, French, and Provençal."

[65] *Romania,* 52 (1926): 257–295. The studies by René Louis and Lot's reaction to them will be the subject of a separate article. The studies are as follows: René Louis, *De l'histoire à la légende,* I (Auxerre, 1946) and, by the same author, *Girart comte de Vienne dans les Chansons de geste* (Auxerre, 1947); Ferdinand Lot, "Encore la légende de Girart de Roussillon, à propos d'une livre recent," *Romania,* 70 (1948): 192–233, 355–396.

[66] The conflict between Charles the Bald and Girart and the exemption of Vézelay and Pothières took place in 868. This would be the point of departure for those who believe in tracing the Girart legend to a historical nucleus. See Chaume, *op. cit.,* I: 248, 249. Aside from Charles's "byzantinizing" tendencies, this was the time when comparisons between the Greek and the Roman emperors were of much pertinence. See the famous letter written by Louis II to the Greek emperor about 870 (Böhmer, Mühlbacher, Lechner, *Die Regenten des Kaiserreiches unter den Karolingern 751–918* [Leipzig, 1885], No. 1247). The letter seemed spurious to Kleinclausz, *op. cit.,* p. 441; its authenticity has been shown by L. Halphen, *Charlemagne* (Paris, 1947), pp. 410–415.

AFFIRMATIVE "ANY MORE" IN PRESENT-DAY AMERICAN ENGLISH

WALTER H. EITNER

THE term *any more,* used adverbially in negative, interrogative, and hypothetical clauses, is common in American speech. Its employment in the sense of *now, nowadays,* and *further* may be illustrated by these sentences: "The train isn't late any more"; "He cannot be suspected any more"; and "If it rains any more, we'll have a flood." Paralleling this usage regionally is the adverbial *any more* of positive, noninterrogative, and nonhypothetical constructions. Fifty-nine examples listed in the *American Dialect Dictionary*[1] show it appearing initially five times, medially ten times, and finally forty-four times. The following sentences illustrate the three positions: "Any more it's hard to get coal"; "I forget any more how it was"; and "He goes there a good deal any more."

Generally, the sense of *now* or *nowadays* is still implied, sometimes seemingly in contradiction of a former condition, that is: "Coal was easy to get, now it is hard to get"; "I knew how it was, but now I've forgotten"; "Before, he didn't go there very often." This is not always true, however. In the sentence "They still use that custom any more," there is no implied change; and John T. Krumpelmann reports in *American Speech* that, in a statement made to him, "You stay in your office too late any more," there was no necessary implication that he had formerly kept shorter office hours.[2] The senses of the term are similar in the three positions, except in the medial one, where the term seems slightly less pointed and less emphatic, and tends more toward the connotation of *still.*

To judge from the numerous citations of the *American Dialect Dictionary,* affirmative *any more* is employed by the educated as well as by the illiterate, by the urban as well as by the country folk. It is reported in use by teachers and shopgirls; and, in one case, is defended by a native

[1] Wentworth, Harold, *American Dialect Dictionary* (New York, 1944), s.v. *any more.*

[2] Krumpelmann, John T., "West Virginia Peculiarities," *American Speech,* 14 (1939): 156.

college teacher of foreign languages on the ground that *now* and other equivalents seem inadequate and flat. Krumpelmann heard it in the spontaneous and unaffected speech of an honor student and a graduate student, both of West Virginia colleges.[3]

At this point it becomes necessary to find the geographical distribution of the term. The *American Dialect Dictionary* remains the most rewarding first source for the purpose. In its eighty-six definite citations, largely drawn from the pages of *Dialect Notes* and *American Speech* for the years 1903–44, the term is reported as used or known in Illinois, Indiana, Iowa, Kansas, Kentucky, Maryland, Michigan, Montana, New York, Ohio, Pennsylvania, South Carolina, and West Virginia. It is also reported in Ontario. Of these citations, West Virginia has forty-seven; Pennsylvania, eight; Kentucky, six; New York, Ohio, and South Carolina, five each; and none of the other states has more than two. It is reported "not observed" in central New York; it is reported unknown in western Tennessee and in Arkansas.

One's first impression from these figures is that the term is centralized in West Virginia. The entries from that state, however, include at least nineteen for the northern section, four of them specifically from Morgantown, the home of the University of West Virginia and of the dictionary's editor. It may not be unjust to conclude, therefore, that the sampling there was disproportionately large.

Of the eight citations for Pennsylvania, seven are from the southern part of the state; the other is not placed. The six Kentucky citations are from the northeastern section; all but two of them are drawn from the pages of Jesse Stuart's books. All five New York citations are from Elmira, near the Pennsylvania border. Ohio's are from Trumbull County in the northeast, with the exception of one from Columbus toward the south. The five from South Carolina are from the central and southwestern portions of the state. Illinois's informant lives in Dewitt County, in the center of the state; Michigan's in the southeast; Montana's in the south; Ontario's in the southwest; and the remainder are not specifically located.

To augment this record there is a more recent list of citations available in *American Speech*, compiled by A. R. Dunlap, of the University of Delaware.[4] He gives two hundred and fifty informants, a few of whom were college graduates, but most of them were high-school graduates and members of his classes in 1944. The homes of those reporting that they had heard the affirmative *any more* in their own areas are as follows: Delaware, largely the northern part, fifteen; the southern part of Indiana, three; Maryland, near the Delaware border in the north, two; the southern part of Michigan, one; New Jersey, close to the Pennsylvania border, two; the southern part of New York, three; the northeastern and southwestern sections of Ohio, three; the Philadelphia and Pittsburgh areas of Pennsylvania, eight; the extreme southwest of Virginia, one; the northeast and the southwest of West Virginia, two. The others were widely distributed west of the Mississippi in Arizona, California, Iowa, Minnesota, Missouri, Nebraska, Oklahoma, Texas, and Washington. Thirty-two reported that they had heard the expression in other than their home areas; a third of them cited it from Delaware and the others added Alabama, Arkansas, Florida, Mississippi, North Carolina, and Tennessee to the states listed above. The number who reported the term as natives of Delaware, and the number who indicated that they heard it there, make it appear that Delaware is a point of centralization. Again this may be explained by its being the canvassing area. The chance sampling is significant in that the *American Dialect Dictionary* contains no citations for Delaware, whereas Dunlap lists only two informants from West Virginia.

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[3] *Ibid.*, p. 156.

[4] Dunlap, A. R., "Observations on American Colloquial Idiom," *American Speech*, 20 (1945): 12–15.

The combined lists show that affirmative *any more* appears most often in these eight states, in the order of frequency: West Virginia, Pennsylvania, Delaware, New York, Ohio, Kentucky, Indiana, and South Carolina. The term has a rough curve of distribution stretching from the Philadelphia–northern Delaware area westward through the southern part of Pennsylvania, southward through West Virginia, and again westward through northern Kentucky and the southern segments of Indiana and Illinois. In Ohio and New Jersey it appears in areas close to Pennsylvania. It is noticeably absent from North Carolina; but it is evident in the western half of South Carolina. Elsewhere in the southern states it appears only sporadically. It is known in the far West, the Northwest, and in the Great Plains. Apparently the term is unknown in Wisconsin, but it has been noted in Iowa, Kansas, Michigan, Minnesota, and Ontario Province. In New York it is found only in the south, close to Pennsylvania. It is unknown in New England.

The problem now is to ascertain as far as possible the origin of the locution in this country. H. L. Mencken seems to hold that it stems from the Germans of Pennsylvania.[5] This view can be largely put aside because the term's distribution in Pennsylvania does not coincide with the settlement area of those people. Its obvious spread throughout the United States generally also indicates another origin. A suggestion of Welsh sources, advanced by R. Whitney Tucker,[6] is prompted in part by the prevalence of the term in mining regions. This may similarly be discounted because of its distribution elsewhere.

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[5] Mencken, H. L., *The American Language: Supplement II* (New York, 1948), pp. 203, 204, 234.

A more likely source is the Scotch-Irish who entered Pennsylvania through the port of Philadelphia in great numbers, beginning around 1720. Their early influx was almost as large as that of the Germans. It also almost equaled the combined numbers of Quakers and others of English origin. Leaving Pennsylvania, many of them went southward and to the interior. They then established themselves in the back country of Maryland, Virginia, and the eastern part of West Virginia. Later they moved west of the Blue Ridge, and eastward into the Piedmont. They were still moving when the Alleghenies were conquered, and were among the earliest to enter the Ohio country and to follow the Ohio River westward. Thereafter the opening frontiers as far as Oregon and Washington always had the Scotch-Irish as a part of their populations.[7]

This general migration from the seaboard to the interior and westward coincides fairly neatly with the distribution of affirmative *any more*. Also, since the Scotch-Irish were too few and too scattered in New England to resist early absorption into the general population of those states, and thereby lost their group identities,[8] it is not surprising that the locution does not appear there. This would also tend to explain its absence from the main part of New York, largely settled by migrants from New England. On the other hand, the wave of Scotch-Irish into Ontario in the 1820's[9] may account for the presence of the term in that section.

The Scotch-Irish theory of origin is supported by the listings of *any more* found in the *English Dialect Dictionary*[10] and the *Scottish National Dictionary*.[11] The former cites the use of the term in positive as well as negative phrases to express the sense of *from now on,* and gives an un-dated example from North Ireland: "A servant being instructed how to act will answer 'I will do it any more.' " The *Scottish National Dictionary* illustrates its use adverbially and affirmatively in the sense of *now, henceforth.* It gives two examples, dated 1928, from Argyll in mid-Scotland, which is that part of the country most convenient to North Ireland: "There's no herring in it the day, but there'll be herring any more," and "It's waarm for the time o'year an it'll be waarmer any more."

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[6] Tucker, R. Whitney, "Notes on the Philadelphia Dialect," *American Speech*, 19 (1944): 39.

[7] See Albert C. Baugh, *A History of the English Language* (New York, 1935), pp. 415–421, and Clinton Stoddard Burr, *America's Race Heritage* (New York, 1922), pp. 44–47.

[8] Burr, *op. cit.*, p. 46.

[9] See Evelyn R. Ahrend, "Ontario Speech," *American Speech*, 9 (1934): 136–139.

[10] Wright, Joseph, ed., *The English Dialect Dictionary* (New York, 1898), s.v. *any*, 3.

[11] Grant, William, ed., *The Scottish National Dictionary* (Edinburgh, n.d.), s.v. *any more.*

That affirmative *any more* is a development within the English language itself may be demonstrated historically. In this regard the *Oxford English Dictionary* and the concordances to Shakespeare and the Bible are most helpful. According to the former, the word *any* was primarily used in interrogative, hypothetical, and conditional forms of speech.[12] Citations date back as far as the year 1000. It was also used as an emphatic negative from a date about as early.[13] Around 1300 its use in affirmative sentences appears: "The serpent . . . was more wise than any beast" (*Cursor Mundi,* l. 700).[14] Shortly thereafter, around 1330, it became joined with *more,* which had also been used since 1000 in negative, interrogative, and hypothetical contexts. The phrase *any more* then superseded the simple *more* in adverbial usage in a conditional sense of *further, longer, again.*[15] Thus the negative, hypothetical, and interrogative *any more* was established. Robert Manning of Brunne employed it in his *Chronicle* (l. 14001) of 1338: "And if you challenge him any more, He shall send you such as these are."

Later (about 1400) *any* came into use adverbially with comparative adjectives.[16] In Caxton's *Enydos* (xix, 72) of 1490 there is the phrase "to presse me wyth wordes ony more." After that, affirmative *any more* appears in Shakespeare's *Richard II* (II, ii, 208) of about 1595, "I'll hate him everlastingly that bids me be of comfort any more," and in the Bible (1611) in the two near-negative instances, "Saul shall *despair* to seek me any more" (1 Sam. 27, 1), and "*feared* to help Ammon any more" (2 Sam. 10, 9).

It appears not unreasonable to suppose, therefore, that *any more* has followed the development of *any* from the negative, interrogative, and conditional into the affirmative usages. The conditional use of *more* with *any* around 1330 may easily have led to the later affirmative use. It is no broad jump from "If we hear the voice any more" to "We hear the voice any more."

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[12] *O.E.D.,* s.v. *any,* I, 1, a.

[13] *Ibid.,* s.v. *any,* I, 1, b.

[14] *Ibid.,* s.v. *any,* I, 1, c.

[15] *Ibid.,* s.v. *more,* C, 4.

[16] *Ibid.,* s.v. *any,* II, 7.

The tentative conclusions derived from these sources are that adverbial and affirmative *any more* developed natively in English from conditional formations; that it became localized at a later date in Scotland; that it was transplanted to North Ireland; and that it spread widely in the United States through the immigration of the Scotch-Irish and their movements farther inland.

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ALEXANDER BARCLAY: A PRODUCT OF HIS AGE

SELMA GUTTMAN

SINCE it is an axiom of modern criticism that a writer should be studied in the light of the period in which he lived, it would seem logical that Alexander Barclay, who wrote in the years between the medieval and the Elizabethan periods, should be studied as a transitional figure. Most of his critics have, however, attached to his name the label "medievalist."[1] Actually, there is no more justification for relegating him to the medieval era which preceded him than there would be for evaluating his works in the light of the Renaissance which followed him, for he was a man of his time who fused the old with the new. A reëxamination of his subject matter will demonstrate that many of his sentiments, old-fashioned and modern, parallel those found in the works of his more brilliant contemporaries, particularly in the circle of Sir Thomas More,[2] and that probably one of his reasons for writing *Contra Skeltonum* was his conviction that Skelton entertained outmoded ideas.

I

Before defending these theses in detail, it is necessary to review briefly the chief works in Barclay's canon. Barclay's major works were either translations of writings by Continental humanists or works compatible with contemporary humanistic interests. Earlier critics have clearly demonstrated that Barclay, acquainted with both Locher's Latin and Rivière's French version of *The Ship of Fools,* depended far more heavily upon the former,[3] but these critics have not satisfactorily explained the reason for his preference. A possible reason for his choice may be the stronger humanistic tone of Locher's Latin version. In this connection it is interesting to note that Barclay translated with vigorous enthusiasm passages found in Locher, but slighted or omitted in Rivière, that express sentiments with which the circle of More was in sympathy.[4] Also in several passages Barclay, by deviating from Locher, approached more closely to the viewpoint of the More coterie.[5] His *Eclogues* were largely translated from two Continental humanists, Mantuan and Aeneas Sylvius. He translated his *Mirrour of Good Maners* at the request of Sir Gyles Alington, a man who entrusted his son's upbringing to Sir Thomas More — strong evidence that Alington and More were spiritually in accord.[6] Barclay translated the *Jugurthine War* of Sallust, an author whom Erasmus highly recommended in *De ratione studii.* Barclay's French text, *The Introductory to Write and to Pronounce Frenche,* the first French grammar ever published,[7] must have stimulated the current interest in languages.

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[1] Koelbing, Arthur, "Barclay and Skelton" in *The Cambridge History of English Literature* (Cambridge, 1918), III, 61, 66; John M. Berdan, *Early English Poetry* (New York, 1920), p. 253; Beatrice White, Editor, *The Eclogues of Alexander Barclay* (Early English Text Society, Original Series, No. 175; London, 1928), p. lxii.

In the body of *The English Versions of "The Ship of Fools"* (London, New York, 1925), Aurelius Pompen effectively comments upon several of Barclay's humanistic attitudes. In his conclusion, however, Pompen paradoxically states (p. 307): "In 1509 he is still fully a late medievalist."

Alfred Pollard approaches the truth more closely but unfortunately does not discuss the matter in detail in his Introduction to Pierre Gringore, *The Castell of Labour* (Edinburgh, 1905), p. xxxix.

[2] Of course, even More was influenced by the medieval tradition. See R. W. Chambers, *Thomas More* (New York [1936]), *passim*. However, More is generally described as a humanist, although that label also causes confusion because of its different connotations.

The choice of such subject matter should suffice to assure Barclay's place in the history of ideas in England and does not justify the assumption that Barclay was a man influenced solely by the era which preceded his birth. Rather, it suggests the opposite. By his choice of material he was popularizing, and sometimes introducing into England, concepts which are generally credited to the circle of More. Nor can these concepts in Barclay be considered merely the result of unthinking, mechanical translation. Barclay did not follow his sources slavishly.[8] On the contrary, he used them as an aid in airing ideas in which he believed. He frequently elaborated upon certain ideas in his sources with which he was in sympathy and deliberately inserted his own philosophical comments at will. Since he showed marked freedom in his manipulation of translated and original material and since he repeated many of the concepts of *The Ship of Fools* — translated and original — in his *Eclogues* and in *The Mirrour of Good Maners,* his translations should be considered a mirror of his own thought. On religion and economics, too, he agreed with More's group.

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[3] For a detailed analysis see Pompen, *op. cit., passim.*

[4] E.g., Barclay, Alexander, discussion of grammar, *The Ship of Fools,* ed. T. H. Jamieson (Edinburgh and London, 1874), I, 144; discussion of Greek, *ibid.,* II, 160.

[5] See below for Barclay's attitude toward logic and for references *passim* to his original passages.

[6] White, *op. cit.,* p. xxvi.

[7] *The Ship of Fools,* I, lxxiv.

[8] Compare Barclay's *Ship of Fools* with Watson's pedestrian and literal translation of that work, also published in 1509, and Barclay's *Eclogues* and *Mirrour of Good Maners* with the doggerel verse of Turbervile's literal renditions of those works. See White's comparative edition of Barclay's *Eclogues.*

II

Scattered throughout Barclay's works are passages heaping scorn upon outdated studies and attitudes. The distortions of medieval logic, medieval grammar, medieval geometry, medieval devotion to bookish authority, and medieval scientific and religious superstitions — all come in for censure.

Barclay's scorn of the scholastic system of logic is so apparent that even his sternest detractor cannot be blind to it.[9] A rather general attack against logic, in *The Mirrour of Good Maners,* was translated quite literally from the Latin.[10] On the other hand, a vigorous and obviously sincere diatribe against logic which occurs in *The Ship of Fools* shows considerable freedom.[11] In his third and fourth stanzas, for example, Barclay observed:

It is ynoughe therof to knowe the grounde
And nat therin to wast all thy lyfe holly.

Here he was deviating from Locher, who condemned logic without qualification, but was agreeing with the pronouncements of Erasmus.[12]

In the same chapter of *The Ship of Fools,* Barclay attacked those who relied upon the "olde dotrinall" of the medieval grammarian Alexander Gallus.[13] Barclay's passage was based upon Locher, but Barclay recommended not only Locher's choice, the grammarian Priscian, who was acceptable in both the Medieval and Renaissance periods, but also the contemporary grammarian Sulpicius, of whom no mention was made in any of Barclay's sources. Sulpicius was popular among the humanists.[14]

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[9] Berdan, *loc. cit.*

[10] Barclay, Alexander, *The Mirrour of Good Maners,* tr. from Dominike Mancin, reprinted for the Spenser Society, 1885, p. 16.

[11] *The Ship of Fools,* I, 144–145.

[12] Woodward, W. H., *Desiderius Erasmus: Concerning the Aim and Method of Education* (Cambridge, 1904), pp. 133, 165.

[13] On Gallus see Epistle 9 of *Epistolae obscurorum virorum,* ed. F. G. Stokes (New Haven, London, 1925), p. 28.

[14] Pompen, *op. cit.*, pp. 209–211.

Erasmus praised him in the first edition of *De ratione studii,*[15] and More recommended him in verses appended to John Holt's *Milk for Children.*

Like Thomas More,[16] Barclay venerated learning, but held virtue and true godliness in even higher esteem. He extolled self-knowledge in an original Envoy in *The Ship of Fools* and observed that he would rather men know how to guide themselves than that they study geography. The very same sentiment was expressed by More and Erasmus.[17] It must be kept in mind that Barclay was not condemning the spirit of scientific inquiry in his attacks against geography,[18] Berdan notwithstanding,[19] but, rather, was following his sources in attacking the encyclopedic geographers of medieval stamp whose conclusions depended upon pseudoscience, the manipulation of the geometric compass, and a slavish dependence upon the old accepted authorities, Strabo and Ptolemy, to whose errors he called attention. Although he did not exhibit the love of adventure found in the later Elizabethan sea dogs or in his contemporary, John Rastell, there is a tone of intellectual open-mindedness in his lines:

> And here after shall by our successours
> Parchaunce mo [lands] be founde, wherin men dwell
> Of whome we neuer before this same harde tell.

This thought, lacking in Locher's version of *The Ship of Fools,* is probably original with Barclay, although there is a very slight possibility that it may be the bold execution of an ambiguous passage of Pierre Rivière.[20]

In original and in translated passages Barclay was almost as vigorous as More and Erasmus in attacking those who exploited superstition. In an original passage he sarcastically included pilgrims among those who could gull ignorant audiences.[21] He included "fals myracles" among the means by which Antichrist gains a following, although they are not mentioned in his sources.[22] More vivid and specific than its original is a passage freely translated from Locher in which he attacked those who obtained money, particularly from the ignorant, by means of false miracles and false relics.[23] Several years before More depicted his Utopians as despising such arts,[24] Barclay, in an original passage, included among misbelievers

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[15] Baldwin, T. W., *William Shakspere's Small Latine and Lesse Greeke* (Urbana, 1944), I, 79, footnote 12.

[16] More, Thomas, *The Life of John Picus, Erle of Mirandula* in *The Workes of Sir Thomas More* (London, 1557), signature a iiii; *The Utopia,* tr. Raphe Robynson, ed. J. R. Lumby (Cambridge, 1940), p. 150.

[17] *Ibid.,* p. 23. Desiderius Erasmus, *The Praise of Folly,* tr. John Wilson, ed. Mrs. P. S. Allen (Oxford, 1913), pp. 112–113.

[18] *The Ship of Fools,* II, 23–27. A short attack in *The Mirrour of Good Maners,* p. 16, was translated quite literally from the Latin.

[19] Berdan, *loc. cit.*

[20] Rivière, Pierre, *La Nef du folz du monde* (Paris, 1497), p. LIX, verso:

> "Et si aucun hom ne ly cueur
> Ne tira voil a desarroy
> Auant ferdinandus le roy
> Sur mer neautmoins sont astables
> Et gens quasi innumerables"

[21] *The Ship of Fools,* II, 68.

> Nat onely they that wytche craftis do
> But they also that gyue to them credence
> Or them supportyth with fauour or defence.[25]

Barclay's sympathy with the circle of More lay not only in his rejection of certain medieval superstitions and academic concepts but also in his espousal of a sympathetic attitude toward the study of Greek and of the Biblical text. He was more specific and detailed than his sources when he disapproved of dilettantism in the study of Latin and of Greek and when he expressed his scorn of those who returned from Greece without a knowledge of the Greek tongue.[26] He reëchoed the praise of Plato and Aristotle found in his sources and inserted this original passage:

> . . . gyue your myndes to scyences lawdable
> Where ye may your herte set and inclyne:
> To Arystotyls or Platoys doctryne.[27]

Barclay and the circle of More recommended that the laity study the Bible. In the preface to his *Novum Instrumentum,* 1516, Erasmus eloquently praised the simple clarity of the Bible and urged that "the sacred Scriptures should be read by the unlearned translated into their vulgar tongue."[28] Barclay, in a vigorous paraphrase of Locher, repeatedly assured his readers that the Gospel "To vs is gyuen in wordes clere and playne."[29] That this was a subject close to his heart is further shown by the fact that elsewhere he deliberately inserted the idea in passages where it did not occur in his originals. The story of Ahab was told in the

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[22] *Ibid.,* II, 228.

[23] *Ibid.,* I, 303. With the last three passages compare *The Praise of Folly,* pp. 80–81.

[24] *The Utopia,* p. 150.

[25] *The Ship of Fools,* II, 191.

[26] *The Mirrour of Good Maners,* p. 71; *The Ship of Fools,* II, 160.

[27] *Ibid.,* I, 147.

[28] Seebohm, Frederick, *The Oxford Reformers* (Third Edition, London, 1887), p. 327.

[29] *The Ship of Fools,* II, 226.

Latin and in the French versions of *The Ship of Fools,* but only in Barclay is the story prefixed by the line:

> Lyke as the Bybyll playnly doth expres.[30]

Elsewhere in another context an original line reads:

> As doth the scripture playne expres and tell.[31]

Barclay reacted in the same way against the overrefinements of the religious exegesists as he did against the oversubtleties of the scholastic logicians. He urged that religious doctrine be taught plainly. In the following passage the last five words are original:

> . . . wysdome and great grace . . . apere
> From a Bysshops mouth by doctryne playne and clere.[32]

The second line of the following passage is original:

> He showyth out the lawes of god omnypotent
> In wordes playne, nat fals ne fraudelent.[33]

The attempt to prefer heresy charges against Colet two years later illustrates the justice of Barclay's complaint in this bitter original passage:

> But he that is in Stody ay ferme and diligent
> And without al fauour prechyth Chrystys lore
> Of al the Comontye nowe adayes is sore shent
> And by Estates thretened to Pryson oft therfore.
> Thus what auayle is it, to vs to Stody more:
> To knowe outher scripture, trouth, wysedom, or vertue
> Syns fewe, or none without fauour dare them shewe?[34]

Like Erasmus, Barclay wished his audience to read the Bible for themselves. In *The Mirrour of Good Maners,* written expressly for young readers, he inserted these original lines:

> Let hope and bolde spirite all misery excell,
> Aduert what is written plainly in the Gospell[35]

and in *The Ship of Fools:*

> Rede howe the Gospell examples doth expres
> Of the pouertye of Christe our sauyour.
>
> . . . . .
>
> Wherfore blynde man make clere thy ignoraunce
> Take here example by god omnypotent.[36]

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[30] *Ibid.,* II, 102. [31] *Ibid.,* II, 159. [32] *Ibid.,* II, 229.
[33] *Ibid.,* II, 233. [34] *Ibid.,* I, 22.
[35] *The Mirrour of Good Maners,* p. 46.
[36] *The Ship of Fools,* II, 106–107.

Barclay's political and economic attitudes were the result of a fusion of Biblical teachings and of contemporary Tudor philosophy. His attacks against those who refused to aid the poor were frequent and sincere. Not only did he give a vigorous and elaborate treatment to such passages on this subject as he found in his sources, but he frequently introduced the topic himself in his *Eclogues, The Mirrour of Good Maners,*[37] and *The Ship of Fools.* Of the last of these, Jamieson has observed: "Had the authorship been unknown it would most certainly have been ascribed to a Langlande of the period. . . . Everywhere he stands up boldly in behalf of the oppressed."[38] It is, however, unnecessary to hunt up medieval parallels for Barclay's sympathy with the downtrodden, for in the early sixteenth century the circle of More joined Barclay in serving as their mouthpiece. In *Of Gentylnes and Nobylyte,* John Rastell complained:

> They [the rich] wyll rathyr suffer theyr neyghbers
> To sterue for hunger & cold & to dye
> Or they wyll gyfe to help them a peny.[39]

Rastell's illustrious relative, Thomas More, devoted a large portion of the first book of *The Utopia* to criticizing the tragic conditions of England's poor who were forced into crime by their economic situation.

Barclay clearly blamed the powerful for the plight of England's oppressed in this original passage:

> "But this hath bene sene forsooth and euer shall,
> That the greater fishe deuoureth vp the small."
> "A right true example mate Coridon doubtlesse,
> So mightie rulers the simple folke oppresse."[40]

In another original passage Barclay observed that, whereas the petty thief plays the rôle of criminal, the great thief acts the part of judge,[41] a theme which was also expounded by Erasmus.[42] In Eclogue V, which was based upon the Sixth Eclogue of Mantuan, Barclay described how superior agricultural workers were to the indolent rich of the city. Close parallels to this passage occur in the works of More, Erasmus, and Rastell.[43]

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[37] E.g., *Eclogues,* p. 204; *The Mirrour of Good Maners,* p. 61.

[38] *The Ship of Fools,* I, xx.

[39] Signature B ii verso. On Rastell's authorship see A. W. Reed, *Early Tudor Drama* (London, 1926), pp. 106–112. See also *The Utopia,* p. 162.

[40] *Eclogues,* p. 120.

[41] *The Mirrour of Good Maners,* p. 34.

[42] Erasmus, Desiderius, *The Education of a Christian Prince,* tr. Lester K. Born (New York, 1936), p. 230. Lawyers were attacked by More in *The Utopia,* pp. 126–128; and frequently by Barclay, as in *The Ship of Fools,* I, 24–28, in which many of the more effective lines were original.

They all made similar suggestions for correcting the injustices they denounced. Using Plato as his authority, Erasmus deprecated too great inequality in material wealth.[44] Thomas More, who also cited Plato, went further: "I holde wel with Plato, and doe nothinge marveille, that he woulde make no lawes for them, that refused those lawes, whereby all men shoulde have and enjoye equall portions of welthes and commodities."[45] And John Rastell maintained:

Nor I thynk it not resonable nother
One man to lyf by labour of an nother
For ych man is borne to labour truly.[46]

Barclay not only translated such passages as the nostalgic description of communal life in the Golden Age,[47] but also inserted original lines in Eclogue V which read:

O damnable deede, so many for to spill,
One wretched carkasse and belly for to fill.[48]

These even stronger lines, also original, occur in Eclogue IV:

But Codrus I clawe oft where it doth not itche,
To see ten beggers and halfe a dosen riche,
Truely me thinketh this wrong pertition,
And namely sith all ought be after one.[49]

Were all these similarities between Barclay and the circle of More the result of personal association? As several of his critics have noted, Barclay did praise More's lifelong friend, Colet, in a passage in Eclogue IV, in which he commended Colet's stress on the unimportance of material possessions.[50] According to Beatrice White, the strongest evidence linking Barclay with the humanists is his reference to Gaguin.[51] That his allusions to Cardinal Morton may also serve as a tenuous link between Barclay and the circle of More has hitherto been ignored.[52] Cardinal

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[43] *The Utopia*, p. 161; *The Education of a Christian Prince*, p. 226; *Of Gentylnes and Nobylyte*, signature A iv verso.

[44] *The Education of a Christian Prince*, p. 217.

[45] *The Utopia*, p. 62. See also p. 160.

[46] *Of Gentylnes and Nobylyte*, signature B iv.

[47] *The Ship of Fools*, II, 103–104.

[48] *Eclogues*, p. 201.

[49] *Ibid.*, p. 143.

[50] *Ibid.*, p. 156. Of course, More also recommended this attitude in *The Utopia*.

[51] *Eclogues*, p. x.

[52] *Ibid.*, pp. 16, 124–125, 159.

Morton was the patron of the playwright Medwall, whose *Fulgens and Lucres* was based upon the *De vera nobilitate* of the Italian humanist, Bonaccorso of Pistoja, the younger.[53] Also, Thomas More spent several formative years of his youth under Cardinal Morton's roof. Indeed, a few years after Barclay's eulogies of Morton were published in the *Eclogues,* More's Hythloday spoke of Morton in a similar vein.[54] Unfortunately, these few allusions are insufficient to prove or to disprove that Barclay was personally acquainted with Sir Thomas More and his friends. The question is, however, of relatively minor significance. Of far greater importance is the fact that the similarities between Barclay and the circle of More on academic, religious, and economic problems testify to their having lived in the same intellectual milieu.

III

Additional light may be thrown on Barclay's intellectual position by studying the relationship between him and Skelton. Such a study will show that Barclay was in accord with Skelton only on those points on which Skelton and the circle of More were in accord and that Barclay differed from Skelton on most of those points on which Skelton and the circle of More differed.

Hitherto critics have been unable to find a satisfactory explanation for Barclay's having written *Contra Skeltonum,* which is, unfortunately, no longer extant. Jamieson's suggestion that "Skelton's scathing sarcasm against the priesthood no doubt woke his brother satirist's ire"[55] ignores the bitterness of Barclay's own attacks against clerical abuse. Indeed, although their literary styles were poles apart, their attitudes on religious abuse were so similar that Albert Rey cites a few of the parallels to support his erroneous thesis that Skelton borrowed directly from *The Ship of Fools.*[56] In the passages noted by Rey and elsewhere, Barclay was in accord with Skelton in castigating many clerical abuses. Both attacked upstart prelates (*a*).[57] Both attacked simony (*b*).[57] Both attacked clerics who were ignorant and clerics who neglected their flocks

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[53] Medwall's opinions on nobility paralleled those of Erasmus, More, Rastell, and Barclay.

[54] *The Utopia,* pp. 27–28.

[55] *The Ship of Fools,* I, lxxx.

[56] Rey, Albert, *Skelton's Satirical Poems in Their Relationship to Lydgate's Order of Fools, Cock Lorell's Bote, and Barclay's Ship of Fools* (Bern, 1899), pp. 53–58.

[57] Skelton handles (*d*) in *Ware the Hawk* and the other vices here listed in *Colin Clout, passim.* Barclay treats them all in *The Ship of Fools:* (*a*) in original

(*c*).[57] They both disapproved of unseemly behavior in church (*d*).[57] They both frowned upon such heretics as Lollards (*e*)[57] and upon such concepts as that of predestination (*f*).[57] Barclay, like the circle of More,[58] was attacking the evils of an entire religious system, whereas Skelton concentrated upon the evils of one man, Wolsey. It is possible, however, that Barclay's reference to "the butchers dogges wood"[59] was intended as an allusion to Wolsey, as the term "butcher's dog" so frequently was in Skelton. If so, the two poets were in accord in their attitude toward the Cardinal. Among minor points of agreement between Skelton and Barclay may be included their attacks against courtly life[60] and gambling,[61] both popular subjects for satire in the early sixteenth century. These issues, obviously, caused no conflict between the two poets but rather demonstrate that Barclay was dealing with problems current in his day.

What, then, caused Barclay to write *Contra Skeltonum?* His extant references to Skelton may throw some light on the question.[62] In one reference to poets laureate in *The Ship of Fools* he merely aired the *ubi sunt* motif.[63] In his chapter on boasting he attacked poets laureate as braggarts.[64] In still another passage in *The Ship of Fools* he condemned the wantonness of Skelton's writings.[65] In the elaborate diatribe in Eclogue IV he again portrayed Skelton as vainglorious and immoral but added two new, significant charges: Skelton was ignorant and his style was poor.[66] Barclay was not alone in so maintaining. The English humanist William Lilly made the following pronouncement:

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passages beginning "Courters become prestis," I, 158 and "From the kechyn," II, 59; (*b*) and (*c*) in his original Envoy, II, 63; (*c*) in two original lines beginning "Suche caytyfs and courters," II, 59; (*d*) in II, 153–157 and I, 220–224; (*e*) in I, 195; (*f*) in I, 271–275.

[58] See More's Latin epigrams; Erasmus, *Praise of Folly,* pp. 81–84, 114–187; Colet's "Sermon to the Convocation for the Extirpation of Heresy," 1512.

[59] *Eclogues,* p. xxii.

[60] Barclay's first three eclogues and *The Ship of Fools, passim;* Skelton, *The Bouge of Court;* More's *Utopia* I; Wyatt's *Satires.* For Erasmus' attitude see Seebohm, *op. cit.,* p. 126.

[61] Skelton, *The Bouge of Court;* Barclay, *The Ship of Fools,* II, 69–74; Erasmus, *The Praise of Folly,* p. 80; More, *The Utopia,* p. 80.

[62] Barclay did not name Skelton in any of his extant works. In one passage he criticized *Phylyp the Sparowe.* The other allusions are merely to poets laureate. The tone of these allusions, however, together with the title of Barclay's *Contra Skeltonum,* leaves no doubt that Skelton was the laureate being attacked. On this point Barclay's critics are in agreement.

[63] *The Ship of Fools,* I, 270.

[64] *Ibid.,* II, 65. [65] *Ibid.,* II, 331.

[66] *Eclogues,* pp. 165–166.

Skelton thou art, let all men know it,
Neither learned, nor a Poet.[67]

Barclay's entire attack against Skelton in the *Eclogues* was strongly influenced by his Latin source, but his criticism of Skelton's scholarship seems to stem from a deep-seated difference in point of view, a difference which can easily be demonstrated by comparing Barclay's attitudes on academic matters with those of Skelton.

Skelton praised the study of logic, frequently criticizing those who were ignorant of the subject;[68] whereas Barclay, as has already been shown, scorned the overstress on logic. In praising grammar Skelton coupled the name Priscian with that of Alexander Gallus;[69] on the other hand, Barclay, approving the premedieval Priscian, mocked the "dotrinall" of Gallus and recommended, instead, Sulpicius, whose outlook opposed that of the medieval grammarians. Skelton used medieval astrological dating in the introductions to such poems as *The Bouge of Court* and *The Garland of Laurell;* Barclay frowned upon the study of medieval astronomy and medieval geometry. In short, Barclay attacked most of the medieval curriculum, whereas Skelton used the trivium and quadrivium as a criterion of intellectual merit.[70] Skelton bewailed the fact that the new stress on Greek was pushing the older disciplines into the shade;[71] Barclay recommended the study of Aristotle and Plato. Skelton showed high respect for academic titles, particularly that of doctor;[72] Barclay mocked at such ostentation.[73] Barclay credited the humanist Robert Gaguin with being the source of one of his chapters in *The Ship of Fools*.[74] Not only did Skelton in *The Garland of Laurel* say that Gaguin "frownéd on me full angerly and pale,"[75] but he also wrote *The Recule against Gaguin.* Nelson notes that Skelton disapproved of Erasmus' Biblical translation;[76] Barclay, although he did object to distortions of the Biblical text, urged the popularization of the Scriptures.

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[67] As translated by Thomas Fuller in *The History of the Worthies of England,* ed. John Nichols ([London], 1811), II, 136.

[68] Skelton, John, *Colin Clout* in *The Complete Poems,* ed. Philip Henderson (London and Toronto, 1931), p. 307.

[69] *Speak, Parrot* in *The Complete Poems,* p. 265.

[70] *Ibid.,* and *Why Come Ye Not to Court?* in *The Complete Poems,* p. 353.

[71] *Speak, Parrot, op. cit.,* p. 265.

[72] *Why Come Ye Not to Court, op. cit.,* p. 353.

[73] *The Ship of Fools,* II, 65 and 245.

[74] *Eclogues,* p. x.

[75] Skelton, *The Complete Works,* p. 408.

[76] Nelson, William, *John Skelton Laureate* (New York, 1939), p. 155.

These differences between Skelton and Barclay closely resemble those which existed between Skelton and the circle of More. Dunbabin lists the characteristics of the More-Erasmus group and includes, besides a knowledge of Latin and Greek, "a distaste for the old cycle of University studies and a correspondingly low regard for University degrees, a firm belief in the efficacy of a humanistic education as an agency in social reform, a desire to simplify theology by discarding the complicated systems of the Schoolmen and reviving the study of the Fathers of the Church, small respect for many of the ceremonies and practices of contemporary Christianity, and a strong feeling against the monastic system. Now none of these marks of the humanist are to be found in Skelton."[77] But most of them are to be found in Barclay.[78] Thus the differences between Barclay and Skelton further illustrate Barclay's sympathy with the ideas of the circle of Thomas More. It is a possibility that some of these points of difference were aired in the lost *Contra Skeltonum* and that that work, were it extant, might further demonstrate the accord between Barclay and the More coterie.

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[77] Dunbabin, R. L., "Notes on Skelton: Skelton's Relation to Humanism," *Modern Language Review,* 12 (1917): 129–130. See also Nelson, *op. cit.,* pp. 38–39. Erasmus did praise the scholarship of Skelton, but Dunbabin and Nelson show that this was merely a politic compliment which should not be taken seriously.

[78] A number of passages not discussed in this study also support this contention. For instance, although Barclay approved of the ideals of monasticism, he criticized its abuses in two detailed passages. Elaborating considerably on Locher, the first appears in *The Ship of Fools,* II, 60–61; the second, *ibid.,* II, 323–328.

NATURE IN THE WORKS OF CERTAIN LATIN-AMERICAN NOVELISTS

THOMAS A. McGUIRE

FOR the purposes of this study I have used as my chief sources novels essentially realistic in character, written by men whom Torres-Ríoseco chooses to classify as *novelistas de la tierra* because *más acercan al motivo genuinamente americano*.[1] They are Mariano Azuela, Rómulo Gallegos, Ricardo Güiraldes, Benito Lynch, Carlos Reyles, and José Eustasio Rivera. For supplementary material to support the evidence offered by their works I have drawn upon other realistic novels published within the last thirty years.

Those who are familiar with W. H. Hudson's works, such as *Green Mansions* or *The Purple Land,* or perhaps even with the jungle tales of Kipling, will find in these Latin-American novels very few of the lyrical descriptions and pictures of the beauties of nature in all its variegated aspects which characterize the English writers, although in many of them the setting or the background is identical. For the most part, the landscape, the mountains, the jungle, and the plain are mentioned briefly in a line or two as a basis for a *cuadro de costumbres,* for a presentation of some character analysis or, as will be shown in detail later, they are described as distinctly hostile and forbidding. There are, however, some examples of the more conventional qualification of inanimate nature as pleasant and propitious. Here is one from *Los de abajo:*

> Fué una verdadera mañana de nupcias. Había llovido la víspera toda la noche y el cielo amanecía entoldado de blancas nubes . . . Los soldados caminan . . . contagiados de la alegría de la mañana.[2]

The following scene is found in Ciro Alegría's *El mundo es ancho y ajeno:*

> Era una hermosa hora. La gran luna llena, lenta y redonda, alum-

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[1] Torres-Ríoseco, Arturo, *Grandes novelistas de la América Hispana* (Berkeley and Los Angeles, 1941), I: vii.

[2] Azuela, Mariano, *Los de abajo* (México, 1941), p. 255.

> braba las faldas tranquilas, el caserío dormido, los cerros altos, el nevado lejano y señero.[3]

Noteworthy because of the infrequency of its occurrence is the characterization of nature as peaceful:

> Hay una paz solemne en la naturaleza,[4]

and as capable of bringing peace to those who are in close contact with it:

> Un sol tierno alumbraba ahora en torno a Marcos Vargas sencillas escenas de comienzos de mundos y una nueva sensación de sí mismo . . . lo envolvía en la suave voluptuosidad de una paz profunda.[5]

Even more unusual in the works of Benito Lynch[6] is his enumeration of the things which have no meaning for the young English archaeologist in *El Inglés de los güesos:*

> para él no fueron ni serían nunca esas bellas flores . . . medio ocultas en las matorrales de las laderas o columpiándose al borde de los abismos; porque para él no fueron ni serían nunca esos hermosos valles de color de esmeralda que, convidando al retozo, se divisan desde la altura como gemas engastadas en el gris elefante de la montaña; porque para él no fueron ni serían nunca los manantiales sonoros que allá, en el fondo de los precipicios, triscan entre las negras piedras como corderos de espuma.
>
> La sombra de los bosquecillos misteriosos, el agua cristalina de los arroyuelos, el canto de los pájaros y el perfume de las flores; . . . todo eso era y sería más bien para los incapaces, para los abúlicos, para los decadentes, para los poetas y para los locos.[7]

On the other hand, some men find peace, hope, and relief in the contemplation of and association with nature. In *Cuna de cóndores* the Indian Pilque, who is forced to spend the night in the mountain with the dead body of his companion, looks at the starry night and all his terror vanishes:

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[3] Alegría, Ciro, *El mundo es ancho y ajeno* (Santiago, 1941), p. 152.

[4] Lynch, Benito, *Los caranchos de la Florida* (Buenos Aires, 1920), p. 201.

[5] Gallegos, Rómulo, *Canaima* (Buenos Aires–México, 1941), p. 288.

[6] Torres-Ríoseco, *op. cit.*, p. 149, says in reference to Benito Lynch: "El paisaje, cielo y llanura, quedará descrito en dos líneas y lo demás sería cuadro de costumbres, o interpretación psicológica."

[7] Lynch, Benito, *El Inglés de los güesos* (Buenos Aires, 1937), pp. 192–193.

> ¡Qué dulce frescura llenó su alma atormentada al recibir después del horror del agujero la serenidad estrellada de la noche de la sierra! La vida parecíale clara y agradable.[8]

Similarly, in *Los caranchos de la Florida* young Pancho, worried and confused because of malicious gossip about his father, recovers new hope in the bright dawn of a new day:

> y todas las dudas que atenazaban su cerebro van huyendo ahora, arrolladas por aquella luz de aurora, que engendra la esperanza del hombre más escéptico y llena su horizonte de promesas.[9]

So, too, in *Canaima,* a somewhat mysterious and foreign count Gioffaro says that he finds in the isolation of the forest

> válvulas de escape a las inmundicias que van acumulando dentro del alma, afin de que no lleguen a intoxicárnosla por completo. Y para esto, no hay como la selva.[10]

At times there is a personification of certain natural elements. The *sierra* is a witness which does not argue or annoy; the river and trees scarcely listen; only the wind hears:

> La sierra es un testigo que no importuna ni discute. El río apenas escucha eternamente apresurado. No oyen los robles . . . Sólo el viento parece entenderlo . . . .[11]

The wind and a lagoon become friendly living spirits:

> El viento era un viejo amigo suyo y pasaba acariciándole la piel curtida.[12]

> La laguna es para él como una vieja e inolvidable amiga.[13]

The sun, the wind, and the storm are brothers and sisters to be neither feared nor cursed:

> Es el desierto pero nadie se siente solo; son nuestros hermanos el sol, el viento y la tempestad. Ni se les teme ni se les maldice.[14]

Another phase in this personification of and brotherhood with natural elements is a sort of vague identification of them with man himself, either as integral parts of his spirit,

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[8] Latorre, Mariano, *Cuna de cóndores* (*Santiago,* 1943), p. 170.

[9] *Los caranchos de la Florida,* p. 122.

[10] *Canaima,* p. 198.

[11] *Cuna de cóndores,* p. 132.

[12] *El mundo es ancho y ajeno,* p. 154.

[13] *Los caranchos de la Florida,* p. 34.

[14] Rivera, José Eustasio, *La vorágine* (Nueva York, 1929), p. 21.

> Cada peñasco, cada arbolillo . . . son partes integrantes de su espíritu. Comprende que si un rayo partiera un espino . . . sentiría igualmente un claro en su vida,[15]

or as a fellow sufferer in life's struggles :

> Ese arbolillo seco y nervudo era como él. Como él quiso luchar contra las aguas ciegas del torrente con el huracán que desemboca en la garganta del alfoz, contra la nieve. Aquel michay de las cumbres era como él. Así se había opuesto su espíritu a la injusticia.[16]

We might mention here an intermediate stage between the references to nature as pleasant — rather limited in number — and to nature as hostile. It is a sort of indifferent or neutral attitude in which the unchanging beauty of landscape becomes wearisome and oppressive:

> Las jornadas de andar cabizbajo y callado ante la abrumadora belleza extraña del panorama, siempre igual y siempre imponente verde sombrío y silencio.[17]

Unfortunate experiences due to conflicts with nature are accepted with indifference or resignation:

> Aquí es bello existir. Hasta la muerte alienta vida. . . . Y cuando a uno se lo traga el río, igual. Ya sabemos de la lucha con él.[18]

In spite of the references to nature in a propitious and pleasing or even indifferent mood, the predominant and inescapable impression which pervades most of these novels is that of *la Naturaleza* as hostile, forbidding, cruel, and harsh. There is a fairly constant spirit of antipathy ranging all the way from mild depression and uneasiness to outright violence. Representative of the milder attitude are the scenes in which some aspect of nature offers a mood or an impression which is vaguely responsible for or in harmony with the depressed, melancholy spirit of the observer. It may be the saddening effect of twilight:

> aquellos rasgos del panorama crepuscular que armonizaban con los melancólicos sentimientos de espíritu . . . .[19]

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[15] *Cuna de cóndores*, p. 127. [16] *Ibid.*, p. 143. [17] *Canaima*, p. 189.

[18] Alegría, Ciro, *La serpiente de oro* (Santiago, 1935), p. 11.

[19] *Canaima*, p. 84.

> como siempre el espectáculo del atardecer ha derramado en el espíritu de aquellos hombres, una sombra tenue de tristeza y de melancolia.[20]

Again, it may be the monotonous beating of the rain

> que engendra en el espíritu melancolias y nostalgias.[21]

Night, especially in the *sierra,* may inspire fear and a sense of frailty because

> la noche altiplánica es lobrega como un lago de petróleo,[22]

and one who finds himself

> frente a la noche . . . siente de pronto un terror enorme que le anuda los sentidos. En el silencio cósmico de la noche recién se da cuenta de su angustiosa pequeñez.[23]

As we read one author after another we become aware that man is generally engaged in some sort of struggle with his environment. In the high regions the men from the low country, the plains, or the coast feel depressed, isolated, and trapped:

> Siempre le han tormentado los cerros, esas cumbres arriscadas de dramática negrura que parecen cercar y encerrar al ser humano para aislarlo del resto del mundo y matarlo de tristeza.[24]

On the other hand, the men of the *sierra* feel the same way on the plains:

> La planicie . . . se dilataba inmensa en su desolación.
> —¡Yo no sé que siento por acá que ma da tanta tristeza! —dijo Demetrio.
> —Sí —contestó Camila —, lo mismo a mí.[25]
>
> —¡A la sierra! ¡A la sierra! No hay como la sierra. La planicie seguía oprimiendo sus pechos; hablaron de la sierra con entusiasmo y delirio.[26]

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[20] *Los caranchos de la Florida,* p. 38.

[21] *Ibid.,* p. 23.

[22] Blym, Hugo, *Puna* (Santiago, 1941), p. 100.

[23] *Ibid.,* p. 98. For a similar passage see Reyles, Carlos, *El gaucho Florido* (Montevideo, 1932), p. 9. See also John A. Crow, Editor, *Horacio Quiroga. Sus mejores cuentos* (México, 1943), note on p. 270 (referring to *En la noche*): "la única [de las narraciones quiroguianas] en que una mujer lucha con la naturaleza como muchos de los personajes masculinos del autor."

[24] *El mundo es ancho y ajeno,* p. 272.

[25] *Los de abajo,* p. 192.

[26] *Ibid.,* p. 198.

Even the Indians sometimes find nature incomprehensible and threatening:

> Los indios mismos . . . se mostraban más reservados que de costumbre . . . cual si la naturaleza se les hubiese vuelto de pronto incomprensible y amenazante.[27]

Such is the influence of the wild solitudes that men, stripped of normal human restraints, yield themselves to a frenzy of cruelty:

> y la influencia deshumanizante de la soledad salvaje, venía produciendo en aquellos hombres, una sombría propensión caracteristica de la selva, cierto frenesí de crueldad.[28]

These rather general quotations give us some idea of the spirit of antagonism, terror, danger, mistrust, and mystery in the world of nature, but even more striking and conclusive are the specific references to the origin of this spirit in tangible sources such as storms, trees, rivers, plains, and jungle. Especially effective are the descriptions of tropical storms which begin to work their spell long before they break forth in all their fury. The whole atmosphere is filled with a

> congoja precursora de tormenta,[29]

and an anguished foreboding pervades everyone:

> Aproximábase el término de la estación lluviosa y hacía varios días que reinaba esa tregua que toman las lluvias antes de desatarse en los tremendos chubascos finales del invierno tropical. Calmas enervantes y prolongadas durante las cuales el silencio de la fronda inmóvil sentíase cargado de presagios angustiosos, hacían irrespirable el aire.[30]

The pages of these novels are filled with descriptions of actual storms with all their usual accompaniments of heavy rain, wind, and lightning without much to differentiate one from another. More interesting for our present purpose, however, is their effect on man and his attitude toward them. An indication of the direful results of continual rain on the *llanos* is given in the following quotation from *Doña Bárbara:*

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[27] *Canaima,* p. 229. [28] *Ibid.,* p. 230.

[29] Gallegos, Rómulo, *Cantaclaro* (Buenos Aires–México, 1944), p. 171.

[30] *Canaima,* p. 229. Cf. also *Los caranchos de la Florida,* p. 45: "Una gran tormenta . . . avanza. Se diría que el peso de aquella sombra . . . irrita el calor hasta el punto de hacer el ambiente irrespirable."

> ¡Llueve, llueve, llueve! Hace días no sucede otra cosa . . . .
> ¡Llueve, llueve, llueve! Y se desbordan los caños y se inundan los esteros y empiezan a caer los hombres, fulminados por "la calentura," tiritando de frío, castañeteando los dientes, y se ponen pálidos y se van volviendo verdes, y empiezan a nacerle cruces al cementerio,[31]

and this one from *La vorágine:*

> Nosotros callábamos también en el tramo opuesto, viendo caer el agua en la extensión de la umbrosa vega, que oprimía el espíritu con sus neblinas y cerrazones.[32]

This reaction towards tropical storms is a natural one when we realize that

> los días de lluvia . . . en la selva suelen ser semanas y meses tras meses.[33]

Much more startling is the characterization of nature in a few of these works as hostile and capable of producing disastrous effects on the mind of man. In *La vorágine* there is a very unusual passage in which trees are described exactly as if they were human beings. They are friendly, perverse, aggressive, or hypnotizing and, furthermore, they have their own way of fighting enemies:

> Cualquiera de estos árboles se amansaría, tornándose amistoso y hasta risueño en un parque, en un camino, en una llanura donde nadie lo sangrara ni lo persiguiera; mas aquí todos son perversos, o agresivos o hipotizantes.
>
> En estos silencios, bajo estas sombras, tienen su manera de combatirnos; algo nos asusta; algo nos crispa . . . y queremos huir.[34]

In *Canaima* there appears a similar sort of personification in which dark, hostile trees seem to move stealthily to close the holes made in their ranks by intruders:

> Negros árboles hostiles que por momentos parecen ponerse en marcha sigilosa para cerrar aquel hueco que arbrieron los hombres intrusos.[35]

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[31] Gallegos, Rómulo, *Doña Bárbara* (Buenos Aires–México, 1944), p. 205.

[32] *La vorágine,* p. 138.

[33] *Canaima,* p. 212.

[34] *La vorágine,* p. 239.

[35] *Canaima,* p. 190.

The monotonous spectacle of trees without number,

> la obsesión de contemplar a toda hora, de no apartar la mirada del monótono espectáculo de un árbol y otro y otro y otro, todos iguales, todos erguidos, todos inmóviles, todos callados,[36]

becomes at length an obsession, exasperating and stultifying:

> ¡Árboles! ¡Árboles! ¡Árboles! La exasperante monotonía de la variedad infinita, lo abrumador de lo múltiple y uno hasta el embrutecimiento.
>
> ¡Barreras de árboles, murallas de árboles, macizos de árboles![37]

The protagonist in Ciro Alegría's novel, *La serpiente de oro*, is a river on whose waters is focused most of the life and activity of a whole community. The men earning their living by ferrying cargoes to and fro are engaged in a constant struggle which all too frequently ends in drowning. An old man who has spent his life under these hazardous conditions sums up the situation in these few words:

> El río también es bravo. De tanto guapir morimos a veces. Pero no le juímos poque semos hombres y tenemos que vivir comues la vida.[38]

Like the trees, mentioned above, the rivers are sometimes personified:

> y aquel que tanto sabía acerca de los grandes ríos de Guayana . . . se los tenía representados, no como simples cursos de agua sino cual seres dotados de una vida misteriosa.[39]

Some of the works which we have been considering have their setting in the *llano*,[40] others in the *selva*, and still others in a combination of the two. In any case there is the same spirit of animosity, of fear and of struggle, which has a distinctly depressing and deadening effect on those who come under its influence and who are forced

> a luchar contra la naturaleza; contra la insalubridad que estaba aniquilando la raza llanera, contra la inundación y la sequía que se disputan la tierra todo el año.[41]

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[36] *Canaima*, p. 213. [37] *Ibid.*, p. 187–188.

[38] *La serpiente de oro*, p. 120. Cf. Torres-Ríoseco *op. cit.*, p. 249 (referring to Alberto Rangel's *El infierno verde*): "Lucha a muerte se entabla entre el hombre y la naturaleza. El caboclo quita terreno al río y éste se venga inundándole su casa y sus cosechas." [39] *Canaima*, p. 29.

[40] Also called *llanura, planicie, pampa*, or *sabana*. [41] *Doña Bárbara*, p. 26.

It is a continual battle against the elements in which

> la muerte es un péndulo que se mueve sobre la llanura, de la inundación a la sequía y de la sequía a la inundación.[42]

The *llano* is mysterious, terrifying, monotonous, obsessing, and deadening:

> Este panorama llanero, esta mezcla absurda de transparencia suma y de misterio — pues lo misterio, lo espantoso del llano, reside precisamente en su excesiva luminosidad —, este paisaje monótono y obsesionante se repite con abrumadora uniformidad.[43]

It may be a cause of fear, a source of evil, an enemy to be fought:

> ese raro temor que . . . inspira el paisaje de la sabana,[44]

> ¡El desierto! ¡El enemigo contra quien primero debemos luchar! La causa de todos nuestros males.[45]

In this connection we might recall the statement about one of the victims of Doña Bárbara:

> Ya Lorenzo había sucumbido, víctima de la devoradora de hombres, que no fué quizá tanto doña Bárbara cuanto la tierra implacable, la tierra brava, con su soledad embrutecedora.[46]

More dangerous than the *llano* and the natural elements which have been discussed up to this point is the *selva* because, as Torres-Ríoseco remarks,

> en estos libros de la selva tropical todo se mueve en una atmósfera trágica y macabra.[47]

The wild animals, insects, and reptiles are indeed deadly enemies.

> pero nada es tan tremendo como la selva misma,[48]

especially when one

> siente sobre sí el abrazo tentacular de la selva . . . esa confusión inextricable de tallos, de lianas, de plantas parásitas.[49]

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[42] *Ibid.*, p. 291.

[43] Güiraldes, Ricardo, *Don Segundo Sombra* (Buenos Aires, 1937), p. 173.

[44] *Cantaclaro*, p. 171.

[45] *Ibid.*, p. 265.

[46] *Doña Bárbara*, p. 278.

[47] *Op. cit.*, p. 249.

[48] *La serpiente de oro*, p. 72.

[49] *El mundo es ancho y ajeno*, p. 383.

The evil effect of this environment on man's character is clearly shown in the following examples:

> La selva trastorna al hombre, desarrollándole los instintos más inhumanos.[50]
>
> la influencia de la selva que pervierte como el alcohol.[51]
>
> En medio de la naturaleza primitiva y salvaje, el hombre se vuelve como ella insensiblemente.[52]

There seems to be a process of deadening of mind and spirit before *el mal de la selva* becomes a reality. The victim feels depressed by the silence and the solitude:

> Tomás se sentía abrumado por el silencio y la soledad infinita del bosque.[53]

Then comes

> la deshumanización hasta el embrutecimiento . . . días y días ante un panorama obsesionante y siempre igual.[54]

A fairly good conception of the feeling of hostility on the part of nature which the reader gets from some of these works can be gained by an analysis of a certain descriptive technique or, more specifically, the frequent use of phrases and adjectives to portray and to intensify the impression desired by the author. When one makes a list of these expressions it resembles a pseudo-litany in which epithets of praise and invocation are replaced by those of despair and fear. For example, the land in general may be called: "la tierra satánica";[55] "las tierras de la violencia impune";[56] "las tierras salvajes, insalubres, inhóspitas";[57] "las misteriosas tierras hondas, calladas, trágicas."[58]

The forest may be referred to as: "el bosque inhóspito";[59] "el bosque antihumano";[60] "los bosques húmedos";[61] "el silencio y la soledad infinita del bosque."[62]

It is in the descriptions of the *selva,* however, that the greatest virtuosity is displayed. Sometimes a simple adjective is sufficient: "selva fascinante,"[63] "laberíntica,"[64] "antihumana,"[65] "tremenda,"[66] "alevosa, embrujadora,"[67] "sádica y virgen,"[68] "profética, enemiga,"[69] "inhóspita,"[70] "inhumana,"[71] "selvas lóbregas."[72]

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[50] *La vorágine,* p. 183.
[51] *Ibid.,* p. 299.
[52] *La serpiente de oro,* p. 74.
[53] *Canaima,* p. 231.
[54] *Ibid.,* p. 288.
[55] *Ibid.,* p. 237.
[56] *Ibid.,* p. 77.
[57] *Ibid.,* p. 166.
[58] *Ibid.,* p. 77.
[59] *Ibid.,* p. 201.
[60] *Ibid.,* p. 212.
[61] Uribe Piedrahita, César, *Toá* (Buenos Aires–México, 1942), p. 66.
[62] *Ibid.,* p. 42.

The same effect is obtained also by somewhat longer expressions such as: "el maleficio influjo de la selva";[73] "la selva que pervierte como el alcohol";[74] "la selva con su misterio fascinante";[75] "el espectáculo monótono y obsesionante de la selva";[76] or a simile may be used in which the *selva* is likened to "una esposa del silencio, madre de la soledad";[77] "una cárcel";[78] "un cementerio enorme";[79] "una catedral de la pesadumbre."[80]

In summarizing what I have been trying to show by textual evidence it may be said that an analysis of these realistic novels discloses that, although there is some interest in the more pleasant aspects of nature, especially when they happen to harmonize with the infrequent cheerful moods of the observer, the main emphasis is on nature as hostile, cruel, forbidding, and treacherous. This, indeed, is the impression that is made on the reader of these works, an impression which, I venture to say, he will retain long after he has forgotten details of plot and character.

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[63] *Canaima,* pp. 188 and 232.

[64] *La serpiente de oro,* p. 76.

[65] *Canaima,* p. 188.

[66] *Ibid.,* p. 229.

[67] *Ibid.,* p. 237.

[68] *La vorágine,* p. 241.

[69] *Ibid.,* p. 149.

[70] *Canaima,* p. 192.

[71] *La vorágine,* p. 240.

[72] *Ibid.,* p. 252.

[73] *Canaima,* p. 229.

[74] *La vorágine,* p. 299.

[75] *Canaima,* p. 193.

[76] *Ibid.,* p. 196.

[77] *La vorágine,* p. 127.

[78] *Ibid.,* p. 232.

[79] *Ibid.,* p. 128.

[80] *Ibid.,* p. 127.

JONATHAN EDWARDS AND THE PRINCIPLE OF SELF-LOVE

CHARLES H. SCHAFER

WHEN Oliver Wendell Holmes undertook in 1880 to belabor a moribund Calvinism in his essay on Jonathan Edwards, he curiously failed to remark upon one of Edwards' chief preoccupations — the principle of self-love. The omission is the more curious when we note that self-love was among his earliest philosophical considerations; that it furnished material for many of his sermons; that it lent impetus to his running feud with Arminianism; and that it is scarcely overstating the case to say his efforts to guard the church from its effects cost him his parish.

There is no need to retell the story of his first encountering Locke's *Essay Concerning Human Understanding* in his sophomore year at Yale. But it is instructive to examine the list of headings which he made when, boylike, he planned a similar study of his own. In notes under the heading "The Mind" he decides

> (3) . . . to have a dissertation, concerning the exceeding vanity, blindness and weakness of the mind of man. — What poor fallible creatures men are. How every man is insensible of his own; thinks himself best. — Concerning the Pride of men; how ready to think they shall be great men, and to promise themselves great things.

He wishes to discover

> (21) Whether or no Self-Love, be the ground of all Love.
>
> (26) How Natural men have a Taste of, and Delight in, that External Beauty, that is a resemblance to Love.
>
> (45) Whether it be possible for a man to love any thing better than himself; and in what sense it is so.[1]

He was not content merely to employ the term "self-love," but at some time before graduation considered its nature carefully and then entered this caveat:

> That, which is often called *Self-Love,* is exceedingly improperly called *Love,* for they do not only say that one loves himself, when he sees something amiable in him-

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[1] Dwight, Sereno E., *The Life of President Edwards* (New York, 1830, ten volumes), I: 664, Appendix H. Volumes II–X are entitled *The Works of President Edwards,* Sereno E. Dwight, ed.

> self, the view of which begets delight. But merely an inclination to pleasure, and averseness to pain, they call Self Love; so that the devils, and other damned spirits, love themselves, not because they see any thing in themselves, which they imagine to be lovely, but merely, because they do not incline to pain but to pleasure . . . Now how improper is it to say, that one loves himself, because what is agreeable to him is agreeable to him: . . . which mere Entity supposes.[2]

Almost forty years were to elapse before these jottings took their final form in *A Dissertation on the Nature of True Virtue,* written in the comparatively peaceful period of his exile in Stockbridge. Meanwhile the consciousness of the problem was often with him. We find entries in his diary remarking how much better he feels when he experiences a sense of humbleness, and more than one entry mentioning the hatefulness of proud men, "worms" who lift themselves up with pride.[3] Believing as he did that the pleasures of humility surpassed all others, he lost no opportunity of inculcating this feeling in others. We are told that he watched his children carefully for the first signs of self-will and pride, when he would "attend to them till he had thoroughly subdued them and brought them to submit; such prudent discipline, being repeated once or twice, was generally sufficient for that child."[4]

At twenty-three Edwards became assistant pastor to his grandfather, the Reverend Solomon Stoddard, who had served the people of Northampton for nearly sixty years. He succeeded to the pulpit after Dr. Stoddard's death two years later, and then began that series of efforts to lead — or, if need be, drive — his people into the way of salvation which has since given him the reputation for hell-fire preaching. That this imputation is unjust becomes apparent when we see how he regarded the majority of mankind, and what he believed to be his duties as minister.

In the first instance, as he explains in the sermon "Men Naturally God's Enemies," only Adam was ever created with the true principle of love to God already in his heart and ruling over his natural instincts. On the occasion of the Fall this true principle was withdrawn; and ever since, men have obeyed their natural impulses and loved themselves.[5] No man can serve two masters; so it follows that one who loves himself cannot love God, and therefore is God's enemy.[6] This, however, may not be apparent to "natural" men, blinded and deafened as they are by self-esteem. It then becomes their minister's duty to show them at once their error and their way. If they are allowed to go undisturbed in this world, then consequences in the next may be appalling. So Edwards, convinced that he was doing the greatest kindness in setting forth their "misery and danger in the liveliest manner," employed all his powers to waken his flock to their danger, and called remiss his colleagues who were restrained in their exhortations.[7] Not even the excesses of the Great Awakening, not even hysteria and suicide, could move him to modify his position.[8]

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[2] Dwight, *op. cit.,* I: 696.

[3] *The Works of President Edwards* (New York, 1884, four volumes, S. Austin, ed.), I: 12. Unless otherwise indicated, all references are to this edition of Edwards' works, which is a reprint of the Worcester edition.

[4] *Ibid.,* I: 29–30. [5] *Ibid.,* IV: 42. [6] *Ibid.*

We should not assume that, in condemning self-love, Edwards thereby refused to admit its necessity. On the contrary, in the affairs of this world self-love is of the greatest importance. Without it society would come at once to a standstill.[9] In some cases God may even permit it to increase for inscrutable reasons of His own, although this argues neither the value of self-love nor the ability of God to sin. Those whose self-esteem has been increased may have been bettered in their earthly sphere without being brought nearer salvation; while God, who has permitted them to sin in order that some general good may come, remains blameless as before.[10] But even the worthiest of men, by the standards of this world, fall infinitely short of that perfection which is attributable to God alone. Those who preen themselves are yielding to Pride, the first and worst of the sins. Not even eminent saints are free of this danger, as Edwards claimed to have seen.[11] Thus, while agreeing with Locke that self-love is paramount on earth, he saw it only as a source of damnation hereafter. "Humility and self diffidence," he urged, "and an entire dependence on our Lord Jesus Christ, will be our best defense."

It was characteristic of Edwards never to shirk a conflict, and never to seek battle on easy terms. When undertaking to attack the Arminian theories of free will, he sought the best work to be had in their defense;[12] and in setting out to convince his people of the danger in which they stood as natural men, he bethought him of the thorniest arguments which might be raised in their defense and demolished them. In sermon after sermon one hears the battle cry, "I shall now proceed to answer Objections." Let Natural Man protest that he has never felt conscious enmity towards God and straightway he is overwhelmed by evidence that he has not searched deeply into his heart; that he has no real belief in the existence of God; that he has deceived himself concerning God's nature; that he flatters himself that God is too far off to be concerned; or, perhaps, that he has yet to undergo a trial of his fortitude.[13] If he protests that he does respect and worship God, his presumption is deflated by demonstrations that the inconstant nature of his worship is evidence of hypocrisy; that his piety bears the marks of training and habit, not conscious dedication; and that his prayers aim rather at personal gain than at the glory of God.[14] These immediate applications are characteristic of Edwards' pulpit approach to the task of scarifying self-love. It seems to have been selected for its general effectiveness. We do not find him attacking self-love on the ground that love towards Being in Particular is inferior to disinterested love towards Being in General, although this argument is implicit in the sermons. The concept of idealism befits the study and is appropriate to *The Nature of True Virtue;* but other terms and more familiar approaches are suitable to the pulpit.

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[7] *Ibid.*, I: 537; III: 335–336. [8] *Ibid.*, III: 245. [9] *Ibid.*, III: 6, 72, 96.

[10] *Ibid.*, III: 69. [11] *Ibid.*, I: 556.

[12] Faust, C. H., and Johnson, T. H., *Jonathan Edwards, Representative Selections, with Introduction, Bibliography and Notes* (New York, 1935, The American Writers Series, Harry Hayden Clark, ed.), p. xlii.

The sermons composing the *History of the Work of Redemption* make this abundantly clear. Edwards is here attacking the idea that man can achieve salvation by his own efforts. Such presumption, in his eyes, brings to naught all God's preparations for the Redemption from the beginning of the world, and makes a mockery of Christ's sacrifice.[15] Step by careful step, Edwards takes his congregation through the events which foreshadow the grace that enables God's elect to shake off their burden of original sin. The cumulative effect is to reduce the powers of the individual to insignificance. Not even reason can prevail when the weight of sin is beyond human power to shift. Christian and Heathen alike have tried it many times, and always have failed. If reason could lead men to grace, Edwards pointed out, the most learned countries in the world — that is, England and France — should be filled with visible saints; whereas they swarmed with Arians, Deists, and other heretics.[16]

The Great Awakening presented Edwards with the dual problem of encouraging the work of salvation as far as possible, while protecting his parish from the dangers of enthusiasm and false conversion. That he was undeterred by the physical and spiritual trials attendant upon conversion is evident from his *Narrative of Surprising Conversions* and, to a lesser extent, from the *Thoughts on the Revival in New England.* He had ample assurance from Scripture that the struggle to break away from one's natural inclinations when turning to God is accompanied by violent reactions. Even Jacob went lame for the rest of his days after wrestling with the angel; and in Edwards' own case, as we learn from the *Personal Narrative,* assurance came only after weeping and agonies of spirit.[17] Hence we find him supporting evangelical preaching, despite the protests of the more moderate Charles Chauncey and others, who would have approached the Kingdom of Heaven with decorum. The inestimable benefits of an eternity of bliss far outweighed their objections.

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[13] *Works,* IV: 45 ff.

[14] *Ibid.,* IV: 50.

[15] *Ibid.,* I: 418, 419; IV: 236, 238.

[16] *Ibid.,* IV: 22.

Towards those who felt they had been converted, Edwards still believed that he had duties as a minister. He knew by experience that a revival creates many partial conversions for every complete one, and in his rigoristic view a partial conversion was none at all.[18] Natural man was natural still, and would return to his old ways as surely as a stone flung into the air will presently begin to fall. Such impressionable folk are easy prey to the enthusiasts, the excited, untrained men who claim to have been shown new and easier roads to salvation and go about leading their victims from the true way. Accordingly he prepared a series of sermons designed to examine the outward manifestations of conversion and show which are false and which trustworthy, for natural men may have a semblance of all kinds of religious affections.[19]

For those who openly rejoiced in their good fortune and looked down upon their unsanctified neighbors, he pointed out many acknowledged saints who had no consciousness of their superiority to others, or who had great doubts of themselves. Moses, descending from Sinai with the tablets, was unaware that the skin of his face shone.[20] Pride and the Spirit of God are seldom present together. Nor is it a good sign to be zealous against one's sinful neighbor. To profess a consuming love for God, while despising His creatures, is inconsistent. Edwards observed that the pleasant feelings attendant upon a supposed conversion will often cause a proud man to congratulate himself. The sequent pleasure affects him still more, in a kind of spiritual chain reaction, out of which rises a fiery zeal.[21] "While a Natural Man thinks," Edwards concludes dryly, "that if there be a heaven and hell, the latter, and not the former, belongs to him; then he will hardly be persuaded that there is a heaven or hell: but when he comes to be persuaded, that hell belongs only to other folks, and not to him, then he can easily allow the reality of hell . . . and may be full of a great zeal against the infidelity that denies it."[22]

The enthusiasts presented an equally difficult problem. The leaders, convinced that their false revelations were true, were like "mad men . . .

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[17] *Ibid.,* I: 24 ff.

[18] *Ibid.,* III: 172 ff.

[19] *Ibid.,* III: 35–36.

[20] *Ibid.,* III: 148.

[21] *Ibid.,* III: 99.

[22] *Ibid.,* III: 137.

who maintain it against all reason and evidence."[23] With such there was little to be done; but perhaps their followers might be saved if they could be shown that they had been misled, that their consciences rather than their souls had been affected. All natural men have a conscience, which Edwards defined as a natural principle, and God may work upon it so that its owner is greatly affected. But this is only nature which is moved, not the soul; and so the conversion is incomplete.[24] Until the Spirit of God actually enters into a man and becomes part of him, he cannot be said to have achieved grace, just as a black stone upon which the sun shines remains black.[25] This must have been sad hearing to those who had undergone that communal excitement in which the participants "are suddenly and unaccountably put into a very agreeable motion. There is first great joy; and then many other affections, in a very tumultuous manner, putting all nature, both body and mind, into a mighty ruffle."[26] But the minister who failed to show them their error, however much he injured their self-esteem, would have been doing them irreparable injury. His duty was to make them aware of their danger by increasing their self-knowledge. True conversion can withstand any examination; but false affection arising from self-love must certainly fall.[27]

If neither pride nor enthusiasm succeeded in misleading natural men, there always remained the Devil to be considered. In these days, when demoniacal possession is often equated with unbalanced endocrines, it is startling to read Edwards' tributes to the subtlety of Satan, ever on the lookout for those on whose credulity and self-love he could work. Satan, though damned and without any qualities of grace whatsoever, can yet exhibit every religious affection within the power of natural men. He is a graduate of the finest possible divinity school, Heaven itself; he can cite Scripture to his own purpose; he did not hesitate to lay hold upon the very person of Christ; and he is completely orthodox, subscribing to every article of faith.[28] If he is all these and yet has no hope of salvation, natural man would do well to beware of following any of the Devil's doctrines. He cannot hope to equal his abilities; and if he could, he would have as little hope of salvation without God's help from within.

When one considers how, for more than twenty years, the parishioners of Northampton were alternately urged to seek salvation and reined back when they felt that they had begun to achieve it, his wonder at the eventual rift between them and their minister is not great. Only an extraordinarily well-disciplined mind such as Edwards' could hope to remain at the stretch for anything approaching that length of time. A man under fire in combat may yield to fear for a while, but eventually he will come to accept and even make light of the dangers which originally terrified him. So it was that Edwards, attempting to make a stand on the matter of improper books circulating among his young people, found himself unable to command anything like the respect he had formerly known. So long as he went no further than private admonitions he had no difficulty; but the moment it appeared that he would name publicly the individuals concerned, self-esteem was affronted, and he was forced to let the matter drop.[29]

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[23] *Works,* III: 52.
[24] *Ibid.,* III: 72.
[25] *Ibid.,* III: 68.
[26] *Ibid.,* III: 110.
[27] *Ibid.,* III: 100.
[28] *Ibid.,* IV: 454–457.

The final rupture, arising from the question of proper qualifications for communion, was in part occasioned by resentment at further assaults on the self-love of the parishioners. Dr. Stoddard had established the principle that all men, natural or converted, were bound to attend communion. It was attacked at first as an innovation, but half a century of usage mellowed it to a custom. Edwards was not satisfied with the simple profession of faith which his grandfather had accepted, and proposed that only such as were real Christians and could make the profession truthfully should be accepted.[30] Logically, the demands were commendable; practically, they were open to question. If a minister has the charge of a parish, he is bound to see that the tares, so difficult to distinguish from the true wheat, are excluded from the field.[31] Moreover, a natural man who from either self-love or ignorance presents himself as a convert is promising something which he cannot fulfill. His self-love may make him confident that he can live a Christian life; but without grace he is certain to backslide sooner or later, adding to his already great burden of sin. Even if he manages to fulfill his promises, God is under no obligation to accord him salvation. Hence the church, if it knows he is unregenerate, must exclude him from communion.[32]

Edwards could not gain a hearing. His church committee refused to allow him to preach on the subject, and when he embodied his views in *An Humble Inquiry into the Rules of the Word of God Concerning the Qualifications Requisite to a Complete Standing and Full Communion in the Visible Christian Church,* the book found but few readers. A series of lectures explaining his position drew curious listeners from other churches, but few from his own. He was dismissed by a large majority vote in June, 1750.[33]

[29] *Ibid.,* I: 36. [30] *Ibid.,* I: 37. [31] *Ibid.,* III: 60.
[32] *Ibid.,* I: 116. [33] *Ibid.,* I: 39.

Edwards' farewell sermon was a model of quiet dignity, in strongest contrast to the violent controversy which had preceded his dismissal. Yet in the midst of his farewell he did not neglect to warn those he was leaving of the dangers attendant upon self-love, either in themselves or others. He bade them beware of those who, for motives of their own, had donned the appearance of saintliness and escaped even his searching examination.[34] He urged them to examine the state of their souls carefully and often, reminding them that those who think themselves "not only true saints, but the most eminent saints in the congregation, are in a peculiar manner a smoke in God's nose."[35] But particularly did he exhort them to maintain a Christian spirit; for "he that rules his spirit, is better than he that takes a city."[36]

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[34] *Works,* I: 80. [35] *Ibid.,* I: 67. [36] *Ibid.,* I: 79.

A SEROLOGICAL INHIBITORY SUBSTANCE ENCOUNTERED IN CERTAIN SYPHILITIC SERA*

JOHN J. ENGELFRIED

A SEROLOGICAL inhibitory phenomenon has been observed in the Serology Laboratories of the United States Naval Medical School at Bethesda, Maryland, which may help explain certain instances of seronegativity in the presence of syphilis (7). Inactivated day-old sera from thirteen cases of early primary untreated syphilis, confirmed for Treponema pallidum by dark-field examinations as well as by clinical evidence, gave negative reactions with different precipitation tests and negative or positive reactions with complement fixation tests. These same sera, after eight days of aging and subsequent to reinactivation, gave positive reactions in the majority of instances. Fifteen specimens obtained from nine other seronegative untreated patients, with positive dark fields for Treponema pallidum and clinical evidence for early syphilis, remained negative in all tests after aging in the icebox. These findings raised the question whether a substance inhibitory to serologic reactions in syphilis is contained in inactivated fresh serum and not in inactivated aged serum. Serological evidence of this inhibitory substance will be presented in this article.

EXPERIMENTS

The serologic tests employed in this study were the standard Kahn, cardiolipin Kahn (2–6), two cardio-slide tests performed with the same technique (1) but with two different lots of cardiolipin antigen, and also the Mazzini and Kolmer tests. All serum specimens were heated for thirty minutes at 56° C. and tested within twenty minutes. On each retest the sera were reheated for ten minutes at the same temperature. All specimens were stored in a refrigerator at approximately 10° C.

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The opinions or assertions contained here are the private ones of the writer and are not to be construed as official or reflecting the views of the Navy Department or the Naval Service at large.

Table I gives a protocol of nineteen sera from thirteen untreated patients with early primary syphilis, examined serologically one day after venipuncture and again after aging the specimens eight days in the refrigerator. It is evident from this table that all the standard Kahn, cardiolipin Kahn, and Mazzini tests gave negative reactions one day after venipuncture. One of the cardiolipin antigens used with the slide test gave four doubtful reactions, while three doubtful results were obtained with the other antigen. Seven positive and four negative reactions occurred with the Kolmer antigen. The Kolmer tests were set up the day after venipuncture and completed the next morning, a delay that may explain the greater number of positive results occurring in this test with one-day-old sera. After aging these sera for eight days, positive reactions were obtained in the majority of tests. The results obtained from the fifteen specimens taken from the other nine seronegative patients are not included in this table, since all tests remained negative when the sera were reëxamined after aging for the eight days.

To study further this phenomenon, 144 sera from nonsyphilitic patients and normal individuals were tested with the standard Kahn, cardiolipin Kahn, and both cardio-slide tests. Negative results were obtained with all tests on these sera when made before and after aging. Aging sera did not cause any change in the serologic reactions obtained in the examination of twenty-two specimens from sixteen treated latent syphilitics.

Having observed that inactivated sera from some seronegative patients with early primary syphilis possessed serological inhibitory properties when twenty-four hours old, the investigator desired to find if these sera would exert inhibitory effects on sera known to give positive serologic reactions. Table II summarizes the results of these experiments. When equal parts of one-day-old sera having this inhibitory property were mixed with each of five positive reacting sera and inactivated, negative results occurred. For control purposes these positive-reacting sera were diluted with known negative specimens, inactivated and tested, and positive results were obtained. These experiments indicate that these sera, with inhibitory substance, when twenty-four hours old, were able to block the reactions of known positive sera. With aging, the inhibitory property disappeared.

A quantitative experiment with the serum having inhibitory proper-

TABLE I

REPEATED SEROLOGIC TESTS ON INACTIVATED SERA BEFORE AND AFTER AGING IN REFRIGERATION

Untreated cases of seronegative early primary syphilis *

Serum specimen	Patient's initials	Standard Kahn		Cardiolipin Kahn		Cardio-slides				Mazzini		Kolmer	
						"A"		"B"					
		Before	After	Before	After	Before	After	Before	After	Before	After	Before	After†
1	PK	− − −	4 4 4	− − −	4 4 4	−	+	−	+	..	..	4 4 4 4 4	....
2	PK	− − −	4 4 4	− − −	4 4 4	−	+	−	+	−	+	4 4 4 4 4	4 4 4 4 4
3	PK	− − −	3 4 3	− − −	± 4 4	−	+	−	+	−	+	....	4 4 4 4 −
4	CL	− − −	± 1 3	− − −	1 3	−	±	−	±	..	..	....	....
5	CL	− − ±	− ± 2	− − −	− 2 4	−	+	−	±	−	±	....	....
6	CL	− − −	4 4	− − −	− 3 4	−	+	−	±	..	..	....	....
7	HJ	− − −	− 1 ±	− − −	1 ± ±	−	+	−	±	..	..	....	....
8	HJ	− − −	4 4 4	− − ±	4 4 3	±	+	±	+	−	+	1 1 2 2 1	4 4 4 4 3
9	NS	− − −	3 4 2	− − −	1 4 4	±	+	±	+	−	..	− − − − −	4 4 4 4 −
10	NS	− − −	2 3 3	− ± −	2 4 4	−	±	−	+	..	..	4 4 4 4 −	4 4 4 4 −
11	JM	− − −	4 4 4	− − −	4 4 4	−	+	−	+	..	..	....	4 4 4 4 4
12	MO	− − −	4 4 4	− − −	4 4 4	±	+	±	+	..	..	4 4 4 4 4	....
13	AC	− − −	4 4 4	− − −	4 4 4	−	+	−	+	−	..	4 4 4 4 4	4 4 4 4 4
14	DW	− − −	1 3 4	− − −	− − −	−	+	−	+	..	..	− − − − −	4 4 4 1 −
15	CC	− − −	4 4 4	± ± ±	3 4 4	−	+	−	±	−	+	− − − − −	4 4 4 4 4
16	BC	− − −	3 4 4	− − −	3 4 4	−	+	−	+	−	..	− − − − −	− − − − −
17	RM	− − −	4 4	− − −	...	−	+	−	+	..	..	....	....
18	AR	− − −	4 4 4	− − −	4 4 4	±	+	−	+	..	..	4 4 4 4 4	4 4 4 4 4
19	JS	− − −	4 4 3	− − −	...	−	..	−	..	..	..	....	....

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* Fifteen specimens obtained from nine other seronegative patients remained negative after aging in refrigeration. The diagnosis was confirmed by dark-field examinations for Treponema pallidum.

† Tests labeled "Before" were performed the day following collection of blood; those labeled "After," seven days later. All tests were made on inactivated serum.

TABLE II

SEROLOGICAL INHIBITORY PROPERTIES OF THREE SYPHILITIC SERA

Cases showing ability to inhibit reactions of positive sera

Serum mixtures *	Before aging †				After aging †			
	Standard Kahn	Cardio-Kahn	Cardio-slide		Standard Kahn	Cardio-Kahn	Cardio-slide	
			"A"	"B"			"A"	"B"
CL serum	— — —	— — —	—	—	— 3 4	4 4	+	+
CL serum + positive serum (87)	— — —	— — —	—	—	3 4 4	3 4	..	..
Positive serum (87)	4 4 4	4 4 4	+	+	4 4 4	4 4 4	+	+
Positive serum (87) + negative serum	— 4 4	— 4 4	+	+	1 3 4	4 4	+	+
JM serum	— — —	— — —	—	—	4 4 4	4 4 3	+	+
JM serum + positive serum (57)	— ± ±	— — —	—	±	4 4 4	4 4	+	+
JM serum + positive serum (51)	4 4 4	— — —	—	±	4 4 4	± 4 4	+	+
Positive serum (57) + negative serum	4 4 4	4 4 4	+	+	4 4 4	4 4 4	+	+
Positive serum (51) + negative serum	4 4 4	4 4 4	+	+	4 4 4	4 4 4	+	+
PK serum	— — —	— — —	—	—	4 4 4	4 4 4	+	+
PK serum + positive serum (88)	— — —	± 2 3	±	±	4 4 4	3 4 4	+	+
PK serum + positive serum (56)	— — —	— ± 1	±	±	4 4 4	4 4 4	+	+
Positive serum (88) + negative serum	4 4 4	4 4 4	+	+	4 4 4	4 4 4	+	+
Positive serum (56) + negative serum	4 4 4	4 4 4	+	+	4 4 4	4 4 4	+	+

* All mixtures were made with equal parts of each serum. They were inactivated prior to testing.

† Tests labeled "Before" were performed the day after collection of blood; those labeled "After," five days later.

ties from patient CL was then carried out. A strongly Kahn-positive serum having a quantitative titer of 160 units was chosen for this experiment. Of this serum, 0.2 c.c. quantities were transferred into a series of five Kahn tubes and the following amounts of one-day-old serum from patient CL were added: tube 1, 0.6 c.c.; tube 2, 0.2 c.c.; tube 3, 0.1 c.c.; tube 4, 0.05 c.c.; and tube 5, 0.01 c.c. Negative serum was added to each of the five tubes to make a total serum volume of 1.0 c.c. These mixtures were inactivated and examined with the standard Kahn and with one cardiolipin slide test. Table III summarizes the results of this experiment. It is evident that the mixture containing 60 per cent of the CL serum inhibited the reaction of the strongly positive serum, that the 20 per cent mixture produced partial inhibition of the reactions, and that 10 per cent and even 5 per cent still inhibited the serologic reactions to a small extent.

Table IV summarizes the results of another experiment in which the relationship between the age (in days), of the serum of patient CL and its inhibitory reactivity in the standard Kahn test was investigated. When this serum was one day old, the Kahn reaction was completely negative; when three days old, the Kahn reaction became doubtful; when four days old, the reaction was two plus. After five days' aging, the reaction probably approached its full serologic strength.

TABLE III

POTENCY OF INHIBITORY SUBSTANCE IN CL SERUM

Final dilution of CL serum	Quantity of each serum in tube			Results of tests	
	CL	Positive *	Negative	Cardio-slide ("A" antigen)	Standard Kahn
Percentage	Centimeters				
60	0.6	0.2	0.2	–	– – –
20	0.2	0.2	0.6	±	– 2 3
10	0.1 †	0.2	0.7	+	– 3 4
5	0.05	0.2	0.75	+	1 4 4
1	0.01	0.2	0.79	+	3 4 4

* Quantitative titer, 160 Kahn units.

† The last three dilutions were made by using 0.2 c.c. of the CL serum with negative serum (0.2, 0.4, and 2.0 c.c.); then 0.6 c.c. of negative serum was added to 0.2 c.c. of each dilution. All mixtures were inactivated prior to testing.

TABLE IV

Repeated Serologic Tests on CL Serum after Aging in Refrigeration

(All tests were performed on inactivated serum.)

Age of serum in days	*Results (Standard Kahn)*		
1	–	–	–
3	–	±	2
4	–	3	4
5		4	4
7	3	4	4

SUMMARY

A serological inhibitory substance was encountered in the inactivated sera of thirteen untreated seronegative patients with early primary syphilis. This inhibitory substance disappeared when the serum was aged in the refrigerator.

When positive luetic sera were diluted with sera having this inhibitory substance and were then tested with various antigens, false negative results were obtained. Aging one of these inhibitory sera in the icebox produced a gradual reduction of the inhibitory substance; its complete disappearance was noted in five days.

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PSYCHOLOGICAL STUDIES IN ELECTROSHOCK THERAPY

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ELECTROSHOCK treatment is one of the cornerstones of modern psychiatric practice, but it has been in use in this country for only nine years. In spite of the many thousands of such treatments given every year it is still largely on an empirical basis without, as yet, a satisfactory theoretical foundation. There has been a great deal of clinical observation with some human and animal experimentation. Certain theories are emerging, and these theories are, in turn, influencing the decisions in regard to methodology. Let us review briefly three points of view.

1. The organic-shock syndrome theory holds that the effect of electroshock is to replace the psychotic-personality organization with the organic-shock syndrome, in which the patient is deeply confused and amnesic and is reduced to an infantile type of behavior, sometimes with double incontinence. The type of treatment machine used, high current for short duration; the close grouping of treatments, at least daily, often polydiurnal; and the continuation of blocks of treatments to a fixed number — all contribute to this effect. This point of view is represented by von Baeyer in Germany, Milligan in England, Neymann, Tyler and Löwenbach, and Kennedy and Anchel in the United States.

2. A second point of view, much more widely held, regards the confusion and amnesia of the organic-shock syndrome as a secondary result of treatment, but not as the main purpose of treatment. Kalinowsky and Hoch are the leaders and spokesmen for this group. By this method treatments tend to be spaced, often two or three a week, in order to avoid too great an accumulating confusion. This has been referred to as the standard, classical, or Cerletti-Bini method.

3. The brain-facilitation theory holds that the organic-shock syndrome is an unnecessary and undesirable side effect, and should be avoided by choice of treatment instrument with lower current for longer dura-

tion. Personality reorganization is sought by a concurrent psychotherapy, the patient becoming more alert, more affectively responsive, and more flexible in his thinking during the process of therapy. Here the trend is to avoid memory loss rather than to expect it or to promote it as therapy. This point of view is represented by Wilcox and Liberson.

Numerous reports are now appearing on the psychological functioning of psychotic patients in relation to electroshock treatment. These need to be evaluated in relation to the theory of therapy which lay behind them. Considerable overlapping occurs, such as a psychoanalytically oriented psychotherapy, which may accompany any of these varied methods. Many investigators operate within an accepted framework of method without analyzing the theory underlying the method. Let us now examine some of the reports from the literature in relation to the point of view behind the therapy.

I. PSYCHOLOGICAL STUDIES BASED ON THE ORGANIC-SHOCK SYNDROME THEORY

Von Baeyer and Grobe point out that convulsive therapy often produces memory defects, distrust, confusion, disorientation, sometimes explicit organic psychoses of the Korsakow type. Even aside from these crude unmistakable cerebral-organic disturbances, they regularly observe personality changes which they consider organically caused, such as euphoria, impulsiveness, dullness, overreactivity to the environment, and narrowing of the psychic productivity. They claim that these changes make it impossible for the patient to maintain the endogenous-psychotic experience. They consider shock therapy a symptomatic treatment which does not touch the depth of character.

Flescher gave memory tests before electroshock and at varying periods afterward and found a retrograde amnesia ascribed to a reversible organic reaction. He considered the discharging function of the convulsion to be a means of conveying huge amounts of energy inherent in the death and destructive drives and unloading them in an individually and socially harmless manner.

Levy, Serota, and Grinker reported impaired memory in eight out of eleven patients treated by electric shock, the impairment lasting from one to several weeks and in one patient for several months. The symptoms were compared with the "punch-drunk" syndrome, in which there is permanent damage. However, their major emphasis is on a psychoanalytically oriented psychotherapy, which is more readily possible after electroshock for patients who are inhibited, retarded, and depressed before treatment.

Löwenbach gave shock therapy with the intent of producing an organic confusional state, which was held to be the essential aspect of the therapy. Luborsky studied the psychometric changes in these patients. A battery of tests was administered two or three days before any shocks, twenty hours after the tenth or the eleventh shock, a point of evident shock effects, and again five or six days after the complete series of twelve shocks, an interval during which some recovery might take place. His battery of tests, taken chiefly from the Wechsler-Bellevue scale, the Goodenough drawing of a man, the Stanford-Binet word naming and picture description, and Wells-Ruesch orientation, showed a temporary organic impairment which almost wholly cleared up within a week after the termination of treatment. This was for a group of five schizophrenics. Five depressives, on the other hand, showed improvement in scores on the tests designed to measure organic impairment, both in process of treatment and afterward. The most notable results were in response to a scale in which the subject rated himself according to his degree of liking or disliking certain common activities. Both schizophrenic and depressive patients, particularly the depressive, showed marked affective changes on this like-dislike scale. There was a close correlation between psychiatrists' ratings of improvement after a six-month period and the psychometric evaluation of the before- and after-treatment changes.

Stainbrook studied Rorschach responses in Löwenbach's patients at successive five-minute intervals, starting about fifteen minutes after an electroshock convulsion. The earliest records showed few responses, most of which were simple color namings. Over half of the responses were to the last three colored cards. Individual peculiarities which had occurred before shock still persisted afterward. The reorientation process was accompanied by a gradual shift from overemphasis on details to increased emphasis on wholes, an increase in orderliness, and a change from pure color responses to color form, finally to form color. Movement responses were the last to appear. The hypothesis is offered of a regression after electroshock followed by a maturing process. It is suggested that one typical record is like what would have been predicted for an extreme pathological organic reaction, conforming to Piotrowski's organic signs. Recovery on the Rorschach was typically made within one hour after the convulsion when treated by Löwenbach's method.

Kohlmann, working also from the point of view of the organic-shock syndrome theory, found on the Rorschach after electroshock, increased perseveration, a decrease in the intelligence factors, a reduction in affectivity, and an increase in the symptoms of dementia. His depressives tended to return to the preshock state, whereas the changes in schizophrenics were maintained for an average of six weeks.

Lindner's posttreatment studies based on the Rorschach, done about eight hours after treatment, were likewise based on the thesis that the organic-shock syndrome is the essential therapeutic effect, not an undesirable side effect. The shift is held to be from an endogenous-psychotic to an organic personality structure. The Rorschach test showed these changes most clearly in number of responses, reaction time, relative paucity of movement responses, low form percentage, strong inclination to perseveration, and poor content.

II. PSYCHOLOGICAL STUDIES BASED ON THE STANDARD METHOD IN ELECTROSHOCK

The presence of a variety of organic-psychotic episodes in patients undergoing electric convulsive therapy is recognized by Kalinowsky, but is not considered necessary for therapeutic results. He points out that "confusional treatment" has no better results with schizophrenic patients than the same number of treatments given at greater intervals. Furthermore, much of the improvement is shown during the first four treatments before the patients usually show a memory defect.

The following studies are based on the hypothesis that the confusion and memory loss of the organic reaction are not the goal of therapy, and hence, if present, are an incidental side effect.

There is a large group of studies of memory in relation to electroshock.

Using the Wechsler Memory Scales in two forms, Stone tested two groups of patients, the first group before any treatment and one day after the last treatment, finding a 16 per cent drop from the pretreatment to the posttreatment test. The second group was tested one day after the last treatment and again two weeks thereafter. This group showed a 27 per cent rise in scores. It should be noted that at the time of taking the second test the patients did not usually remember having taken the first test. He concluded that the trend of test scores in cognitive function is downward as psychotic patients receive a series of electroshocks and upward in the postshock period.

Smith and others observed memory loss as a complication of electroshock but found it never permanent. Instead, it was usually a spotty defect, ordinarily for proper names, places, and dates. Brody made the same observation, but cautioned that it implied permanent or semipermanent damage to the brain. Sherman and her associates, on the other hand, found a slight improvement rather than a loss in the pretreatment and posttreatment tests of memory. This was attributed to a previously impaired process of attention and concentration. In their studies of memory in relation to shock Zubin and Barrera found that the recognition method showed almost unimpaired retention, while the savings method in relearning showed no retention but also no impairment of learning ability. Interference in learning in the form of new associations to the original paired words disorganized but did not destroy the memory traces. They observed that the shock affects the learning acquired immediately before shock more than learning acquired less recently before shock. Zubin concludes that the hypothesis that the patient recovers because his memory for adverse events or situations is wiped out is hardly tenable, since no evidence for destruction of memory traces is now available. He postulates that, since the feeling of familiarity bridges the field of memory and the field of emotion, the change in the threshold of familiarity is sufficient to free the patient from his anxieties without a loss of the memory which previously troubled him. Thus the effect of electroshock is to reduce the emotional charge on the patient's associations without alteration in his memory.

Zeaman concurs with Zubin in the interpretation that the loss of feeling of familiarity for emotionally toned associations is a contributing factor toward the recovery of patients treated with shock.

The field of memory of personal history was investigated by Janis for a group of nineteen patients of mixed diagnoses who received a standard course of electroconvulsive shock three times a week for a minimum of eight treatments. The detailed interview was carried out before treatments and again about four weeks after the cessation of treatments. There were definite retroactive amnesias in every case, but these were circumscribed memory gaps selectively determined and were apparently due to subtle emotional factors rather than to any permanent loss in retention. Janis postulates a causal connection between the postshock amnesias and the affective changes produced by the treatments, possibly a repression mechanism secondary to the organic changes. He acknowledges that this memory loss may not be the same in other forms of treatment based on a modification of the shock therapy technique, but does not discuss the variation in theoretical interpretation which would be required.

Let us turn now to a review of the studies of functioning mental efficiency in relation to electroshock. All the published studies have been done on patients treated by the standard method, so that no comparisons are possible with either the organic or the facilitation methods.

Improved mental efficiency as measured by scores on the Hunt-Minnesota test for organic brain damage was recorded by Brooks for a mixed group of psychotic patients, mostly schizophrenic, who received a combination of insulin and electroshock. The scores dropped from a median of seventy-seven before treatment to sixty-nine after treatment, a change significant at the one per cent level of confidence. There were no important changes for the unimproved patients. The Wechsler-Bellevue scores for the same group showed no significant change for the verbal scale on the tests before and after treatment but did manifest a definite improvement on the performance scale, particularly the subtests of picture arrangement and picture completion. She concludes that the general intelligence of the improved psychotic patients increases after shock therapy.

A similar study was done by Kessler, who used twenty schizophrenic patients tested with the Wechsler-Bellevue just before and again about two weeks after a series of electroshocks. Definite improvement was found on both verbal and performance scales, with the greatest changes in comprehension and picture completion. With 70 per cent of the cases clinically improved the psychometric rating of improvement agreed in 95 per cent of the cases with the psychiatric rating of posttreatment condition.

Comparison of mental efficiency before electroshock, immediately following shock, and at a follow-up period, six months after treatment, was made by Huston and Strother for 106 patients by means of the Babcock examination for mental deterioration and the Shipley-Hartford Retreat Scale for measuring intellectual impairment. As expected, the vocabulary scores showed no change. The mean efficiency indices and conceptual quotients, however, were significantly higher on the follow-up tests than either before or after treatment. This was interpreted in the before-treatment group to be the effects of psychosis and in the after-treatment group to be incomplete recovery from the effects of shock. Six months after treatment the patients compared satisfactorily in mental efficiency with a group of normal controls matched for age and vocabulary.

Personality evaluation of patients early in the history of American electroshock was reported by Kelley and others. Rorschach tests were given before and about two hours after a single treatment. Their group of patients of mixed diagnoses showed no clinical psychiatric changes, except for a frequent but not universal amnesia, and no changes in the fundamental Rorschach pattern. They did not remember their previous responses.

A follow-up of Piotrowski's earlier Rorschach studies of insulin-treated patients was made by Pacella, Piotrowski, and Lewis on patients treated with standard electroshock and given the Rorschach test before and again about three weeks after treatment. They evaluate their observations in this statement:

> "The following personality changes have been observed in schizophrenics by means of the Rorschach method after a successful treatment: The patients become much more concise; they are less circumstantial; the logical coherence of their reasoning was improved. There was usually a definite improvement in the capacity for consciously directed and prolonged voluntary attention. They showed more control in thought and action. They were emotionally calmer and less sensitive. At the same time they appeared emotionally duller. These results probably can be explained fully by a decrease of emotional pressure. The decrease in anxiety and depression reacted favorably upon intellectual functioning. Thus, although there seemed to be no real improvement in intellectual capacity, the improvement in intellectual efficiency was very noticeable. The decrease in anxiety through successful treatment resulted in a lesser stimulation of imagination and thus revealed more clearly the emotional impoverishment of the schizophrenic. Finally, as far as the percept-analytic test of Rorschach is concerned, there seemed to be no difference in its prognostic value whether used in insulin coma treatment or in ECT."

Working with a group of depressive patients treated by the usual standard method, Deri found that after electroshock they showed improved motor efficiency and speed, less tolerance for frustrating activity (interpreted as a decreased sense of guilt), more rapid decision times, greater communicability on the Thematic Apperception Test with more dynamic content, and on the Szondi test evidence of release of repressed aggression and at the same time a better personality integration accomplished by strengthening the ego through more efficient repression.

III. PSYCHOLOGICAL STUDIES BASED ON THE BRAIN-FACILITATION THEORY IN ELECTROSHOCK

The variations in electroshock method developed by Friedman-Wilcox-Reiter and by Liberson are based on the assumption that memory disorders and intellectual impairment not only are not the basis of therapy, but should be definitely avoided. To this end there are introduced variations in the wave form of the electric current, a smaller stimulus for a longer duration, together with a variation in the position of the electrodes on the head. Liberson reports that patients receiving treatments by his brief-stimulus technique become reoriented in about half the time they would have after the usual standard type of treatment. They do not show a loss on the Wechsler Memory Scale, the Shipley-Hartford, serial sevens, or the BRL sorting test and usually show a gain after treatment. He found their postconvulsive recall and recognition for implanted memories slightly better after using his technique than after using the type of Reiter technique which was available in 1945. Medlicott compared Liberson's brief-stimulus method with the usual standard technique and found comparable therapeutic results, but much less memory loss for the Liberson method. This held true both for implanted memories and also for relatives' later reports of memory disturbances. Liberson concludes that there is considerably less possibility of brain damage by his method than with the standard method because of the greatly reduced amount of electrical energy needed to elicit a convulsion.

Using the Reiter instrument, Wilcox places a major emphasis on neurophysiological facilitation by means of electroshock. By this method memory disturbances are minimized, and the patient is quickly available to psychotherapy. Rorschach studies by Morgan and Cutts on Wilcox' patients in the early postconvulsive phase have failed to find the Piotrowski organic signs reported by Stainbrook on Löwenbach's patients. At most there is a temporary decrease in the number of responses to the Rorschach but without qualitative change.

Rabin studied ten patients treated by the Reiter method and repeated Stone's finding of a slight loss in cognitive function and memory immediately after a treatment series followed by a later rise. The Rorschach tests indicated an increase in the average speed of response after therapy regardless of the degree of improvement. All his cases who improved had some color or movement and also some shading responses before treatment. Thus he considers that the prerequisites for improvement are some dilatation of personality and some insight and autocriticism. Improvement produced further dilatation. His improved patients showed on the Szondi test a tendency to become more aggressive and to reach out more for other people.

Rabin tested six chronic schizophrenic patients with the Rorschach after they had received from 110 to 234 Reiter-type shock treatments each on a maintenance basis over a period of several years. They showed an extreme schizophrenic picture, mentally impoverished, emotionally dilapidated, dull, vacuous, and repetitive in their productions, with little or no regard for reality and were by and large nonconformists out of harmony with their environment. According to Piotrowski's criteria for organic brain damage, however, only half of this group showed a characteristic organic reaction. Automatic phrasing (a sign frequently observed in organic syndromes) occurs in only one record. Color naming and color description (signs frequently noted in organics as well as very disturbed schizophrenics) are absent from all but one record. Rabin favors a theory that considers the individual reaction of the organism to the treatment as opposed to blanket statements, frequently improperly founded, regarding the inevitably and universally incapacitating effects of shock therapy.

CONCLUSIONS

This paper has summarized the psychological studies from 1940 to 1948 on human electroshock therapy. The extensive literature on animal studies has not been included here because of the difficulty of making satisfactory cross-population references.

There are many problems in the psychology of electroshock therapy which have scarcely been explored and which need much further experimental study. A number of these questions cannot be answered by blanket generalizations or by the use of a single theoretical framework. Some of them are:

1. What are the kind, degree, and duration of memory loss in different clinical syndromes and with different types of electroshock treatment?
2. What is the significance of possible memory loss in the process of therapy of the individual?

3. What are the effects of the varied kinds of electroshock on the personality dynamics of patients? For example, why is it usually more effective with depressive than with schizophrenic patients?

4. Does electroshock produce a fundamental change in personality structure, or does it affect only the peripheral reactions, such as depression and anxiety?

5. What are the differences in clinical effectiveness of electroshock if it is accompanied by or followed by psychotherapy which is more than supportive reassurance?

6. Are there any psychological syndromes or patterns which are contraindicative of electroshock?

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THE RELATION OF HISTORY TO THE THEORY OF DEFINING

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IN THIS paper I want to consider anew a problem which is perennially the object of long and tedious discussion: the epistemological status of definitions.

In the first place, I think it clear that in some sense terms can be used incorrectly. This obvious beginning is, however, the setting for a problem with a not so obvious solution, namely, how we can actually justify the assertion that a term is used in the wrong way. For example, we sometimes hear it said nowadays that science cannot investigate its own presuppositions. I think it makes perfectly good sense to say that anyone who uses the word "science" in this manner is doing so incorrectly; he has a notion of what science means that is incorrect relative to the present stage of our knowledge. Again, anyone who defines "the good" as the "greatest happiness of the greatest number" is inaccurate in terms of contemporary ethical knowledge. The word "happiness," for one thing, has lost all real meaning, and the expression consequently says too little or too much, depending upon the kind of person to whom it is presented.

These are only examples of the incorrect use of terms. However, the main question of present concern is not the correctness of the definitions and uses of terms, but the methodology by means of which we decide that they are.

As a beginning, let me do what all philosophers eventually have to do: make certain distinctions. I am not interested here in the purely formal criteria of defining. That is, I recognize that certain definitions can be considered incorrect within a formal system because they have ignored restrictions on the use of bound variables, for example. These definitions can certainly be attacked as incorrect, and the method of attack is fairly strictly laid down within formal theory. But the examples I have cited do not fall under the head of formal criticism. Rather, I am interested here in what some philosophers call "analysis of concepts." I am interested in the employment of terms in our everyday activities.

Next, I think that definitions and analyses can be considered in several different ways. To make clear the distinction I have in mind, suppose for the moment we say that a definition or an analysis is a sign sequence that directs responses to objects or the properties of objects. This description is not exact, but it will suffice as a basis for the distinction I want to make between arbitrary, conventional, and (let us say) scientific definitions. The distinction is based on the individual who is supposed to be directed by the sign sequence. In some cases the intention is to direct the responses of only one individual; thus I may say that a "boojum" is a Jersey cow, and do this with the intention only of directing my own responses when the word "boojum" is used. If this is my intention, then the sign sequence is an arbitrary definition. In this case the adequacy of the definition is to be judged in terms of the kind of response that is evoked when "boojum" is presented to me. If on hearing "boojum" I still respond to Guernsey as well as Jersey cows at various times, then my arbitrary definition is inadequate. The same remarks apply to conventional definitions. Here the "individual" involved consists of several people, that is, a social group. But the aim is the same: we want the sign sequence to evoke essentially the same responses in all, or the greater part of, the individuals in the group. For example, a committee of social scientists may sit down and attempt to define "attitude." As a beginning, they decide to say that an attitude is "the sum total of all dispositions of an individual with respect to some object or general area." If later on we find that some of them act as though a group of persons were displaying an attitude when they behaved in a certain manner, while others insisted that they were not, then we would say that the original conventional definition is wrong.

In the case of arbitrary and conventional definitions, it seems to be perfectly feasible to assert that a definition is incorrect, and actually to outline the kind of investigation we would have to conduct to ascertain whether our judgment is true. In fact, when I say that the arbitrary definition *D* is wrong, I mean that, if a certain individual's behavior is observed in a number of different contexts, it will be found that *D* does not direct him to respond to any consistent set of objects or properties. By the same token we can set in empirical terms the problem of testing the rightness or the wrongness of conventional definitions. (I want to add parenthetically that the problem of investigating the adequacy of arbitrary and conventional definitions is not nearly as simple as I have outlined, but my main point is merely to show that we could find a common ground for planning the investigation within the fields of psychology or the social sciences.)

The idea behind the judgments on the adequacy of arbitrary and conventional definitions has been one of *communication.* I have really been arguing that a *necessary* (though not sufficient) condition that an arbitrary or a conventional definition be adequate is that it communicate in a certain specified manner. In the case of arbitrary definitions, I have imposed the condition of a sort of self-communication; the sign sequence must communicate in the sense that it directs a single individual to respond to objects or properties in the manner that he originally intended. In the same manner our group of scientists want to be able to communicate with one another in the sense that, when one of them uses a term, all (or most) of the scientific group will respond to the same objects or properties.

Now we come at last to the third type of definition which I have called "scientific." In order to orient the reader, I must explain that what I have in mind here is the notion of the essentially correct definition, independent of a particular individual or group of individuals. I can make my point clear, as well as my subsequent argument, by quoting from Werkmeister's recent book. He says: "The linguistic formulation of ideas for the purpose of communication and the search for truth are two radically different processes and must be clearly distinguished." In fact, "A definition *x* which has no purpose other than to fixate the meaning of a word in the interests of communication is quite different from a definition the purpose of which is to determine the content of a concept in the interest of truth."[1]

In other words, Werkmeister apparently argues that we cannot apply the same criteria to the true or scientific definition that we apply to what I have called arbitrary and conventional definitions. The main question, then, is to ascertain what actually does constitute a valid as opposed to an invalid scientific definition. I know, of course, the traditional forms of expression apropos of this argument: a definition must reveal the essence and eliminate the accidental properties of an object. But to many of us this classical way of putting things is merely a classical way of stating the problem: What are the essential as opposed to the accidental properties? It is true that the Aristotelian theory does imply a certain method, as did Plato's. The method consists of going to experience for the answer, and combining experience with intuition in order to reveal the essential properties. Virtually the same procedure is still used in a great part of modern analysis. Someone will attempt to define "number" or "class" or "existence" or what not. He does so on the basis of his own knowledge and the best advice he can gain from others. Other philosophers now attempt to find "counter-intuitive" examples that reveal the definitional inadequacies: that the definition either failed to cover what all recognize to be essential or did include what all would take to be accidental. And thus the analysis proceeds to another formulation, another counter-intuitive example, and so on.

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[1] Werkmeister, W. H., *The Basis and Structure of Knowledge* (Harper and Bros., 1948), p. 49.

Now I am not too worried about the lack of finality in all this inquiry; all scientific inquiry runs the risk of adopting the wrong roads. What does worry me is the question of whether the method really is adequate to the purpose of definitions. How can we be sure that the counter-intuitive example really destroys an analysis? We could be surer, I think, if we had some information on the manner in which counter-intuition works, that is, the principles that guide its application. It is certainly true that philosophers often disagree in deciding when an example is really counter-intuitive; in these cases the accepted stipulation seems to require that the proposer of the example find one that is "more" counter-intuitive. But the entire procedure seems to rest on very flimsy foundations. In any case I merely want to point out that to use this method by itself does, in effect, make the process of modern analysis a process of conventional definition: the actual consequence of the method at best must be to set up agreement among a very small group of persons in their use of terms.

The problem of finding a really workable method for judging the adequacy of definitions is not an easy one, and I do not mean to belittle what has already been done in this respect in modern science and philosophy. But I do think that there is something to be gained by attempting to extend the inquiry into the method of analysis itself, if we are ever to claim that the method has any scientific validity.

In this paper I can obviously do no more than state a kind of hypothesis with regard to the proper extension of the method of verifying analyses of concepts. To begin with, I have been using the term "scientific definition" throughout this paper. To make the hypothesis I have in mind clear, I must at least clarify my own meaning of the term "scientific," and I must do so in the briefest possible manner. For my present purposes all I need say is that *whatever* science may be, it must be conceived in terms of its history and its infinite prospectus. I mean that there are certain problems of man that are in a sense eternal; they appear in every generation, and as nearly as we can estimate the problems, they will inevitably appear in every future generation as long as there are purposive beings. I say that science is the body of activity designed to bring us closer to the solution of any one or more of these time-persistent problems.

It may help, however, to suggest some of the time-persistent problems that I think fall in the domain of science; a very specialized one would be the true velocity of light *in vacuo,* or the true desires of a human being at a moment of time. A more general one would be the perfect cure for cancer, the best method for accomplishing maximum nonpreferential distribution of goods.

Now what is the rôle of defining in this process of man's persistent attempts to find better solutions of time-persistent problems? I am going to turn back to Werkmeister's assertions, and simply negate them in the formulation of my hypothesis: I now say that the linguistic formulation of ideas for the purpose of communication and the search for truth are *not* radically different processes; in fact, if we take communication in the most general sense (to be explained), a necessary condition for a definition actually to determine the content of a concept "in the interest of truth" is that the definition shall "fixate the meaning of a word in the interests of communication in the most general sense."

My notion is simply this: that, if there are time-persistent problems, then a necessary condition for the most rapid approximation to their solution is that all who work on the problem shall have the most adequate type of communication. We want to set up sign sequences in such a way that there shall be an essential agreement among all those who work on the same problem. A present-day definition, then, to be adequate, must direct contemporary workers to respond as fully as possible to the past and contemporary work on a time-persistent problem. The definition gets at the essence of the concept only if it directs responses to the major reflections, experiments, and other inquiries of persons who have also contributed to the progress in the solution of the problem. A scientific definition must have its roots in a communication with the past; this is to be based on a historical analysis. In such an analysis the definition takes cognizance of the development of the problem. In other words, the definition is given a setting within a historical description of the progressive solutions to a problem. The definition must also have its roots in contemporary activity. This means that the sign sequences must be designed to communicate, not with a special group of persons, but rather with all persons who are potential contributors to the inquiry on the problem. Of course, this assertion makes a large part of our contemporary definitions totally inadequate. We have done woefully little work in finding a language of science that will adequately communicate between fields. Strangely enough, we seem to think it more important to obtain consistent communication in a very narrow domain than to find a communication system that will bring in all potential collaborators. Finally, the definition must have its roots in the future, as well as we can conceive it; it must take into account the possibility of change, and not set its form so rigidly that another age will have to spend fruitless hours breaking the rigidity in order to get ahead. I would like to suggest that a definition which thus adequately communicates with the past, present, and future is a definition which, in Werkmeister's sense, reveals the essence of a concept.

This discussion provides at best only a brief formulation of the kind of criterion I want to suggest for defining. It does make defining an enormous job, a job that one individual, or even a select group, could not conceivably do alone. It has the consequence of taking analysis out of the area of individual speculation based upon individual experience. But it also makes possible a controlled investigation of the adequacy of any proposed definition, for though the difficulties are enormous, I see no reason why we could not reduce the communication criteria I have mentioned to the test of controlled investigation. Please let me reëmphasize that I have given only a necessary condition for the adequacy of a scientific definition; I realize that there may be other aspects of defining, for example, in a formal system, that cannot rightly be included under my criteria.

Perhaps in certain areas of human inquiry my hypothesis will seem an obvious one. A definition of "mass" in physics that ignores general relativity theory is scientifically inadequate. Similarly, a pure associationist definition of "sensation" is inadequate, for it fails to make an adequate response to the work of *gestalt* psychology. Hence, in these fields we seem to be able to recognize fairly clear-cut criteria of adequate and inadequate defining, though it is certainly true that much of scientific language is very crude from the point of view of adequate communication between scientific workers. But in the sense I have suggested here, we can make an objective judgment about a definition of "mass," say, and assert that it is a good or a bad definition in certain respects. The strange thing is that in the field of value inquiry we do not seem to have any such criteria. Suppose I offer a definition of "the good." What judgments can be made about the adequacy of the definition? At present the procedure of attack may take the form of arguing that the definition is syntactically or semantically weak. In addition, in many writings on the subject the position is argued that the assertion "*x* is good" has a persuasive character, and that any proposed definition must be justified by at least showing that the definer intends to persuade as his definition persuades. And the great puzzle to the liberal mind is the question whether anyone can talk of *the* good, as though certain end points of persuasion are absolutely better than others.

I am curious to learn why we ignore a history in studying the definition of the good, while we clearly lean heavily upon such a history in studying the definition of "mass," "sensation," and what not. Is it that we can discern no clear-cut set of time-persistent problems in the case of "the good"? We think we can find out why man has been so curious about the physical world, for such curiosity has furthered us in the time-persistent problem of controlling nature. Is it sensible to ask why man has bothered throughout the ages with the concept of "the good"? Does such a query really lead to a vicious circle? (What good is it to worry about "the good"?) Is there a fairly coherent set of problems associated with the term? Have man's past efforts really amounted to anything in solving these problems? If so, then why can we not judge definitions of "the good" in terms of their ability to make most fruitful use of such past labors?

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PRESIDENTIAL ELECTION REFORM

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THE subject of presidential electoral reform is an exceedingly broad and complicated one. In view of the frequent attention it has received since the adoption of the Constitution it may be termed one of the hardy perennials of American political discussion. Since January 6, 1797, when Representative William L. Smith, of South Carolina, offered in Congress the first constitutional amendment proposal on this subject, hardly a session of Congress has passed without the introduction of one or more resolutions of this character.[1] In the 58-year period between 1889 and 1947, 123 amendment proposals relating to the method of choosing the president were introduced in Congress.[2] The electoral vote tie in 1800 between Jefferson and Burr brought a flurry of amendment proposals of this sort. One of them was eventually adopted in 1804 as the Twelfth Amendment. The election of John Quincy Adams in 1824 by action of the House of Representatives provided the incentive for further efforts at presidential election reform, as did also the disputed election of 1876 between Tilden and Hayes.

These periods of intensified activity, however, have only been high lights in what has been a more or less continuous struggle by reformists in and out of Congress to bring the system of choosing our chief executive into conformity with political reason and reality. Senator Thomas Hart Benton, of Missouri, with the strong support of President Andrew Jackson, made this a prime object of his concern over a period of twenty years in the Senate in the 1820's and 1830's.[3] Senator Oliver H. P. T. Morton, of Indiana, led the fight in the 1870's, without success.[4] In more recent times Senator George W. Norris, of Nebraska, and Representative Clarence Lea, of California, have labored to bring to the attention of Congress and the country a realization of the need for presidential electoral reform. On viewing the net results of their efforts and those of many others over the years, one is tempted to paraphrase a famous remark of Winston Churchill: "Never have so many labored so hard in so worthy a cause, to so little effect."

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[1] For a review and an analysis of amendment proposals dealing with the presidential election system introduced in Congress from 1789 to 1889 see H. V. Ames, *The Proposed Amendments to the Constitution of the United States during the First Century of Its History*, House Doc. No. 353, pt. 2, 54th Cong., 2nd Sess. (1897, Ser. 3550), pp. 77–123; and M. A. Musmanno, *Proposed Amendments to the Constitution*, House Doc. No. 551, 70th Cong., 2nd Sess. (1929, Ser. 9017), pp. 44–51, 60–64, which carries this analysis forward from 1889 to 1928.

[2] *Proposed Amendments to the Constitution of the United States Introduced in Congress from December 4, 1889, to July 2, 1926*, Sen. Doc. No. 93, 69th Cong., 1st Sess., 1926, Ser. 8546, pp. 148, prepared under the direction of Charles C. Tansill; and *Proposed Amendments to the Constitution of the United States Introduced in Congress from the 69th Congress, 2nd Session through the 79th Congress* (1947), pp. 114 (unlisted Senate Document prepared under the direction of Carl A. Loeffler).

Despite the failure of these efforts of a century and a half to achieve substantial change in our presidential election system, the struggle should continue. Anyone with a reasonable degree of familiarity with the functioning of this system must be aware of the needless complexities and the dangers to popular government inherent in it. It is a compound of outworn constitutional provisions, upon which has been superimposed a system of party usages, rules, and practices, interlarded with the provisions of forty-eight different sets of state laws. By these means we regulate the choice of a body of 531 "ghost" electors, who, few people now realize, still perform the solemn and momentous function of designating the persons who will occupy the offices of president and vice-president. In this state of happy national unconcern and popular ignorance about the actual workings of the system, it was not surprising to read in the press last December that one of the Michigan presidential electors, who, of course, belonged to the Republican party, had to be restrained by his colleagues from casting his electoral vote for Mr. Truman and Mr. Barkley when the electors met at Lansing in December.[5] While his desire to make Mr. Truman's election appear to be unanimous was commendable and was understandable in view of the great stress that was placed on the need for national unity in some quarters during the preceding campaign, it is an unfortunately significant commentary on the degree of popular misunderstanding which prevails in the nation regarding the manner in which we actually determine who will be the next president.

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[3] Dougherty, J. H., *The Electoral System of the United States* (1906), pp. 326–342.

[4] *Ibid.*, pp. 89–106, 344–351.

[5] *Ann Arbor News*, Dec. 14, 1948, p. 3. Only thirteen of the nineteen Republican electors appeared in Lansing to perform their duty of casting the state's electoral votes. The six vacant places were filled by appointment by the other electors, as permitted by state law. Six individuals who happened to be around the state capitol were "rounded up" for this purpose. The elector who sought to cast his vote for the Democratic candidates, Mr. J. J. Levy, of Royal Oak, was one of the six substitutes. He was quoted as saying: "I thought we had to vote for the winning candidate. I certainly didn't want to. I'm a Republican and fighting proud of it."

The root of that misunderstanding lies in retention of the electoral college as the agency through which, normally, the choice of a president and a vice-president is officially made. The influence of the electoral vote system on a presidential campaign is felt from the nominating stage to the ascertainment of the final result. As long as the Constitution remains unreformed on this point there will be confusion, misunderstanding, and possibility of miscarriage of the popular will. Consequently there must continue to be waged a frontal attack upon this hoary and outworn relic of the stagecoach era. It must be eliminated from our electoral processes if we are ever to achieve complete assurance that our method of choosing the nation's chief executive conforms to the principle of popular self-rule.

THE INDICTMENT OF THE ELECTORAL COLLEGE SYSTEM

The indictment that can be drawn up against the electoral college system as it now operates is a lengthy one. In general, the various counts in the indictment fall under three main headings: (1) those arising from retention of the office of presidential elector; (2) those which concern the method of determining the issue when no candidate has obtained a majority of the electoral votes; and (3) those which derive from use of the general ticket system in choosing presidential electors. An outline of some of the counts in the indictment under these headings follows.

1. Retention of the Office of Elector

The electoral college has been aptly compared to the vermiform appendix in the human body. While it does no good and ordinarily causes no trouble, it continually exposes the body politic to the danger of political peritonitis. A careful student of the subject has said: "The elector in the constitutional sense is an abortive organism. He has no function to fulfil. But he is not merely functionless, he is dangerous. It is as true in the moral as it is in the material realm that any mechanism or organ that has ceased to perform its function is sure to work mischief, if not positive detriment."[6] In the office of presidential elector we tolerate the continuance of an institution which not only has ceased to have significance but which also has dangerous potentialities for harm.

The first harmful effect that may be noted is the unnecessary confusion of the voter caused by printing on the ballot the names making up

[6] Dougherty, *op. cit.*, pp. 253–254.

the various slates of candidates for presidential elector. The long, actually meaningless lists of rival slates of electoral candidates on the ballot sometimes lead to a voter's spoiling his ballot and thereby disfranchising himself in the most important electoral contest in the nation. Twenty-two of our states have eliminated this particular evil by providing by law for the so-called "presidential short ballot." In these states the names of the party candidates for elector are omitted from the ballot and only the names of the presidential and vice-presidential candidates of the respective parties appear under the appropriate party labels. A vote for the presidential ticket of a particular party is counted as a vote for their slate of electors.[7] In sixteen states the ballots carry the names of the presidential candidates and of the electoral slates as well; in ten states only the names of the electoral candidates appear.[8] With either of the latter two types of ballot, splitting of a voter's choice among various candidates for elector is possible. When this happens, either the result is a spoiled ballot because too many electors are voted for, or the voter, in effect, divides his support between the rival aspirants for the presidency — a most foolish gesture, indeed.

There was much comment on the fact that at the recent election in Ohio approximately 160,000 more votes were cast in the gubernatorial contest than in the presidential contest. In that state, because of litigation that delayed final certification of the Progressive party's slate of electors on the ballot, the electors of that party had to be listed in full on the ballot unaccompanied by the names of the Progressive party's candidates for president and vice-president. The names comprising the Republican and Democratic electoral slates were omitted, under the normal presidential short-ballot plan. Only the names of their presidential and vice-presidential candidates appeared. Because of this peculiar arrangement a large number of voters cast invalid ballots in the presidential contest by voting for Truman or for Dewey (i.e. for their undisclosed electoral slates) and also for some of the Progressive electors as well. Such invalidated choices accounted in large measure for the discrepancy in the presidential and gubernatorial vote totals. These invalidated ballots may well have affected the disposition of the state's electoral votes; for there was a difference of only about 7,000 votes in the Dewey and Truman totals out of a total of almost 3,000,000 votes cast.

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[7] Cf. L. E. Aylesworth, "The Presidential Ballot," *American Political Science Review,* 17 (1923) : 89–96, and "The Presidential Short Ballot," *ibid.,* 24 (1930) : 966–970; S. D. Albright, "The Presidential Short Ballot," *ibid.,* 34 (1940) : 955–959.

[8] For a digest of state and national laws as of 1944 regulating the manner in which presidential electors are voted for and their functioning see *The Electoral College,* Sen. Doc. No. 243, 78th Cong., 2nd Sess., pp. 26, compiled under the direction of Edwin A. Halsey. See also Ruth C. Silva, "State Law on the Nomination, Election, and Instruction of Presidential Electors," *American Political Science Review,* 42 (1948) : 523–529.

A second count in the indictment on this point is that an elector is only morally bound to cast his vote for the candidates of his party for president and vice-president. He cannot be compelled either by state law or by national law to register his choice for the candidates regularly nominated by his party at its national convention. A case arising out of the recent election has established this point. Electors who were presented on the Democratic ballot in four Southern states and were elected as Democrats repudiated the candidates named at their national convention and voted for candidates nominated subsequently at a "rump" states' rights Democratic convention. Attempts to enforce against the Alabama delegation so chosen a state law enacted in 1945 which required presidential electors to cast their votes for the candidates named at their national party convention were unsuccessful, both in the Alabama Supreme Court and in the Federal courts.[9] A Tennessee elector who ran as a candidate on both the regular Democratic slate and the Dixiecrat slate cast his vote for Governor Thurmond, despite the fact that he was elected through receiving a popular plurality of 270,000 on the Democratic ticket and only 73,000 votes as a candidate on the Dixiecrat slate. It thus appears that constitutionally the way is clear for an elector to vote for whomever he prefers, regardless of the action of the national party organization.

Still other dangers that lurk in retention of the office of presidential elector are the possibilities of confusion and uncertainty that can arise by reason of a question of ineligibility of an elector, his death, his failure to function as an elector, or the death of the presidential or vice-presidential candidate of his party before the elector has had an opportunity to discharge his pledge. All these are contingencies that have occurred, and they will undoubtedly recur from time to time. Most states have enacted laws providing for filling vacancies in their presidential elector delegation. The usual provision is an authorization for the other electors to fill the vacancy by appointment. But questions may still arise to throw the outcome of a presidential election in doubt. The Constitution sets up a rule making members of Congress and holders of Federal office ineligible for the office of elector. Not infrequently, however, persons who are constitutionally ineligible run for and are elected to this office. After the recent November election several of the duly chosen electors in Virginia discovered they were ineligible to serve by reason of their holding Federal offices of one sort or another. They resigned their electoral college seats, and others were appointed to their places by the remaining electors before the electoral vote was cast.[10] Had their ineligibility not been discovered in time, and had they cast their votes as electors, the revelation later that they were ineligible would have caused these votes to be invalidated. In an extremely close division of the electoral vote the result of the election could thus be affected.[11]

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[9] In an advisory opinion in April, 1948, the Alabama Supreme Court held the 1945 statute unconstitutional so far as it attempted to control the functioning of presidential electors. *In re Opinion of the Justices,* 250 Ala. 399, 34 So. (2nd) 598 (1948). The statute had not been repealed by the time of the fall election, however. Immediately after the election two suits were filed in which injunctions were sought to compel that state's electors to vote for the candidates of the party ticket upon which they were chosen, viz. the Democratic party. The injunctions were refused in both cases, and the Supreme Court in effect sustained these rulings by rejecting petitions for review. *Folsom et al.* v. *Albritton,* 335 U. S. 882 (1948); *State* v. *Albritton et al.,* 251 Ala. 422, 37 So. (2nd) 640; *Adcock et al.* v. *Albritton et al.,* 335 U. S. 887 (1948).

The outcome of the litigation involving the Alabama statute would indicate that a California statute of similar nature and purpose, *Deering's California Code* (1939), sec. 10555, is likewise void, as is also an Oregon law of this same import, *Oregon Compiled Laws, Anno.* (1940), sec. 81–503 a. Certain other states, including Massachusetts, New Jersey, New York and Virginia, have provisions in their laws which by implication obligate an elector to vote for the regularly nominated candidates of his party. Cf. Silva, *op. cit.,* as cited in note 8.

Again, the electors may fail to function on the day or in the manner prescribed by law. In 1857 the electoral vote of Wisconsin was challenged at the time of the canvass by Congress because that state's electors had been held up by a blizzard and were not able to meet at the state capital to cast their votes on the day appointed by law. The two Houses of Congress were unable to agree on whether the Wisconsin electoral votes were valid or not. They were not decisive, having been cast for Fremont, the losing candidate. A double set of electoral vote results was announced by Congress, one with and one without the Wisconsin votes included.[12]

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[10] *New York Times*, Dec. 14, 1948, p. 35.

[11] The result in the famous disputed election of 1876 actually turned on a question of this sort. One of the three Republican electors who had been chosen in the State of Oregon was a Federal postmaster at the time of his election. On discovering that his Federal office made him ineligible to serve as an elector, he resigned both the electoral seat and the postmastership. He was then appointed to the vacancy by his two Republican colleagues. His somewhat tainted vote, which the Special Electoral Commission accepted, supplied the margin by which Hayes was declared elected. Dougherty, *op. cit.*, pp. 184–202.

[12] Dougherty, *op. cit.*, pp. 51–57. A similar mix-up in the final count occurred in the 1836 election, when Congress could not decide whether or not Michigan's electoral votes should be included. The question arose because Michigan had not achieved full statehood until several weeks after it had chosen presidential electors. *Ibid.*, pp. 48–49.

Still another danger lies in the possibility that a candidate for president or for vice-president may die or be found to be ineligible before the electors pledged to him have discharged their obligation to vote for him. In other words, there is a danger that the electors might some time have a chance to function as the Constitution's framers intended that they should. In the 1872 election this contingency actually occurred, when the Liberal Republican candidate, Horace Greeley, died a few days after the November election. Fortunately, his electors were in the minority, and the outcome of the election was not affected. His electors pursued their various inclinations when they met later to ballot. Some of them named on their ballots for president the vice-presidential candidate of their ticket, and followed their own fancy in voting for some one else for vice-president. But a number were faithful unto death and carried out their implied pledge to vote for Greeley, even though he was in his grave. These votes were lost, the Senate and the House being unable to agree on whether Greeley in his current condition was a "person" within the meaning of the Constitution.[13] In these days, when it is customary immediately after the November election for the victorious candidate to take a trip to some southern clime for the purpose of recuperating from the rigors of the campaign, there is always a possibility that he may fall victim to some unexpected disaster. If this should happen before he has become officially a president-elect, it would place in the hands of 531 obscure individuals the grave responsibility of actually choosing the next president. It should not be forgotten that Franklin D. Roosevelt, while sojourning in Florida before his inauguration in 1933, missed becoming a victim of an assassin's bullet only by a matter of inches.

2. *Method of Settling the Issue after an Inconclusive Electoral Vote*

The second charge against the present electoral system concerns the method of settling the issue in case no candidate receives a majority of the electoral votes. Under the provisions of the Twelfth Amendment, if a candidate is to win by virtue of the electors' votes, he must secure a majority of the whole number of electors, which now means 266 votes. In case no person receives an electoral majority for president, the House of Representatives, voting by state units, elects the president from those receiving the three highest totals of electoral votes. A majority of the state votes, that is, twenty-five, is required to settle the issue. If no candidate for vice-president receives a majority of the electoral votes, the Senate proceeds to choose one of those who received the two highest totals of electoral votes. A majority of the senators is required.

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[13] Dougherty, *op. cit.*, pp. 87–88, 265.

The major criticism of this arrangement is the inequity that results from giving to all states, without regard to differences in population, equal power in deciding the matter. It should be noted that the criticism applies not only to House election of a president but also to Senate election of a vice-president, since the states have equal representation in the latter body. The political injustice in this arrangement is so obvious that it "need only to be stated, not argued," as Senator Morton once observed.[14] It is significant that, on the first occasion when an election of a president was thrown into the House, the political reaction produced the Twelfth Amendment, which made impossible the recurrence of the particular circumstance that necessitated recourse to House action in that instance. When reference to the House had to be made after the 1824 election because of the inconclusiveness of the electoral vote, the reaction was equally strong. While the effort to amend the Constitution to prevent recurrence of such an event in the future failed, the political bitterness that was engendered between the Adams and the Jackson factions was deep. It was one of the underlying reasons for formation of a new political party alignment that endured for a generation.

It should also be noted that there is a possibility that the House decision may be delayed indefinitely beyond January 20, the inauguration day for a new president, when disposition of an election has been placed in its hands. In that event, under the Twentieth Amendment the vice-president-elect would act as president until the House resolved the issue, if ever. It is not difficult to imagine the confusion that would result in case of a long-drawn-out contest. If anyone is inclined to dismiss such a possibility as being too farfetched, let him contemplate what our situation would be now if Governor Dewey's electors in last November's election had succeeded in getting a very few thousand more votes in Ohio and California. Loss of the electoral votes of those states by President Truman would have reduced his electoral vote to 253, less than a majority; but their gain by Mr. Dewey would still not have given him an electoral majority. The election would have been referred to the House of Representatives, with Mr. Truman, Mr. Dewey, and Mr. Thurmond as the three eligibles from whom selection was to be made. The Dixiecrats, it was openly announced, hoped that their candidate's entry into the contest would have just this effect.

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[14] Dougherty, *op. cit.*, p. 23n.

The current make-up of the state delegations in the House indicates that Mr. Truman might have been expected to receive the votes of no more than twenty-one states; Mr. Dewey, of twenty states; Mr. Thurmond, of four; and three state votes would have been ineffective because of the even division of the delegations between Republicans and Democrats.[15] In this contingency the House of Representatives might have fallen into a deadlock, unable to give a majority of the state votes to any candidate. Presumably Vice-President Barkley (we can assume that he would have been chosen vice-president over Governor Warren by a Democratic Senate) would still be acting as president, uncertain from one day to the next when his tenure would end. The possibility of our Ship of State drifting upon the present sea of national and international troubles with only a first mate's hand tentatively on the tiller is not pleasant to contemplate. Had we blundered into such a crisis of uncertainty, even for a short time, it is safe to say that the first problem the Eighty-first Congress would have felt impelled to attack, once it was able to turn to regular legislative work, would have been the submission of a constitutional amendment which would put an end forever to this aspect, at least, of our present system.

3. The General Ticket System of Choosing Electors

Under the third heading in the indictment are found the charges against the electoral college system which probably seem most weighty to the ordinary citizen. The practice which now prevails in all the states by which the party slate of electors receiving a state-wide plurality are all deemed elected,[16] with the consequence that votes cast for the losing slates of electors are completely unrepresented in the state's electoral vote, appears on its face to be indefensible from the standpoint of political justice. It should be observed first, however, that the general ticket system of choosing electors is not a necessary feature of the electoral college plan under the Constitution. The Constitution provides that each state shall appoint its electors "in such manner as the legislature thereof may direct."[17] In the early days of the Republic appointment by the legislature itself was a common practice, vying with election by congressional districts as a mode of selection. Election on a state-wide general ticket was first introduced in a few states in the campaign of 1800. Considerations of state pride and partisan advantage led to its eventual adoption in all the states. From the point of view of constitutional authority the states are now free to establish a more equitable mode of selecting the presidential electors, such as choice by districts.[18] It is extremely unlikely, however, that the states can be induced severally to change from the prevailing mode of choosing electors. Consequently, the general ticket system must be considered a part of the present plan which a constitutional amendment will be required to uproot.

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[15] See the article by Arthur Krock in the *New York Times* on January 14, 1949, p. 22, which is reprinted in the *Congressional Record* (Appendix), 81st Cong., 1st Sess., p. 249.

[16] In Georgia, to be elected by popular action, electors must receive a majority of the popular vote. In case of failure of this requirement to be met, the electors are chosen by the legislature. *Georgia Code, Anno.* (1935), ch. 34, sec. 2502–2503.

[17] Article II, sec. 1, cl. 2.

In the first place, the general ticket system is criticized because it, in effect, disfranchises all those who voted for the losing slates of electors, so far as electoral college representation is concerned. Thus, in 1948 the 1,003,000 voters who voted for Truman electors in Michigan had no representation whatever in the electoral vote count of this state, even though they comprised 47.6 per cent of the number participating in the state balloting; whereas the 1,038,000 who voted for Dewey electors were represented by all 19 of the presidential electors, even though these voters constituted only 49.2 per cent of the participating electorate.

This failure of the popular vote to be accurately reflected in the electoral vote of a particular state is emphasized further in the compilation of national totals. Generally speaking, the percentage of the electoral vote won by the candidate with a national plurality of popular votes is considerably greater than his percentage of the national popular vote; while losing candidates have correspondingly smaller percentages of the electoral votes than their percentages of popular votes nationally. Third-party and minor-party candidates generally are completely "shut out" in the electoral vote. Frequently a result of this failure of the popular vote for particular candidates to be equated accurately in terms of electoral votes is the election of a so-called "minority president"; there have been thirteen such since the 1824 election.

A further charge against the general ticket plan is that it tends to overemphasize the political importance of the large politically doubtful states. Candidates from such states have a great advantage over rivals from other states in the nomination struggle. Sixteen of the twenty-six major-party candidates since 1900 (seventeen if Theodore Roosevelt be considered a major-party candidate in 1912) have come from New York or Ohio. The electoral vote power and the close division of party strength in these states give them a most salubrious climate for the growth of presidential timber. The so-called "pivotal" states also monopolize the attention of the candidates and the campaign fund spenders during the canvass for popular votes, while other areas not regarded as doubtful are ignored. Some of the blame for the relatively poor turnout of voters in presidential elections is also laid at the door of the general ticket system. Voting statistics show a high correlation between the degree of closeness of the state-wide popular vote and the amount of popular participation. In the doubtful states there is a strong incentive for the voter to vote; in states where the outcome on a state-wide basis is a foregone conclusion, there is little incentive for the voter, regardless of his political inclinations, to take the trouble to register his preference.

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[18] *McPherson* v. *Blacker,* 146 U.S. 1 (1892).

Finally, the general ticket system is condemned in some quarters as causing both the major parties to give undue attention to the demands and programs of relatively unimportant minority groups or factions. The Jewish vote, the Negro vote, the Polish vote, or some other such faction may constitute the balance of power between the major parties in a large state or in several such states, even though in the overall national scene the particular group may not be numerically important. Because of the strategic position it occupies it may be the pivot upon which a large block of electoral votes turns; hence the major parties have to make large concessions and enter strong bids for its support. As a consequence major-party programs may be influenced unduly by these strategically located groups, which often prove to be uncertain and even embarrassing party allies in the long run.

CURRENT PROPOSALS FOR REFORM

In recent years three types of constitutional amendment proposals designed to correct some or all of these defects in our presidential election system have had more or less serious consideration in Congress. The first type is represented in a resolution brought forward by Senator George W. Norris, of Nebraska, in 1934. It reached the floor of the Senate and was voted on in that year. It received strong support, but failed of the necessary constitutional two-thirds majority by a narrow margin.[19] The Norris proposal would have done nothing more than abolish the useless office of presidential elector, while retaining all the remaining elements of the present system. Although it would have corrected one major weakness, it would not have improved upon the present method of settling the issue when there is no electoral vote majority; and it would have embedded in the written Constitution the general ticket system of awarding a state's electoral vote, with all of its objectionable features as outlined above.

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[19] The vote was 42 to 24 in favor of passage. On a later motion to reconsider, the vote was 52 to 29. *Congressional Record,* 73rd Cong., 2nd Sess., pp. 9127, 9245. Cf. Joseph E. Kallenbach, "Recent Proposals to Reform the Electoral College System," *American Political Science Review,* 30 (1936) : 924–929.

The second type of proposal which has received Congressional attention in recent years is one which would sweep away entirely the present system of nomination and election and substitute nomination by direct nation-wide primaries and election by a direct nation-wide popular vote. A plurality would suffice to determine the outcome in both cases. The proposal for direct popular election is not new, having been first advanced in Congress in 1826.[20] Currently its Congressional champions are Senator William Langer and Representative William Lemke, of North Dakota, who have introduced amendment proposals in the present Congress to effectuate it.[21] In 1947, during the course of consideration of the proposed amendment to limit presidential tenure to two terms, which was eventually submitted to the states, Senator Langer and Senator Taylor, of Idaho, offered this direct popular vote plan as an amendment to the presidential tenure resolution. Their amendment was rejected by a vote of 66 to 14.[22]

Though this plan would, of course, eliminate all the objectionable features of the present system which have been noted above, it is open to at least three serious criticisms.

First, the substitution of a nation-wide primary for the national convention as a nominating device is questionable from the standpoint of both practicability and desirability. Many authorities on nominating procedures endorse the convention system as preferable to the direct primary even at the state level. Objections to the direct primary at the national level are still more weighty. A more feasible approach to the problem of nominating procedures would seem to lie in improving the convention system, rather than in abolishing it.[23]

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[20] Ames, *op. cit.*, pp. 87–88. During the first hundred years of our history under the Constitution thirty-seven proposals of this nature were introduced in Congress.

[21] S. J. Res. 10 and H. J. Res. 118, 81st Cong., 1st Sess.

[22] *Congressional Record*, 80th Cong., 1st Sess., p. 1962. The votes in favor of the direct popular election proposal were cast by 9 Democrats and 5 Republicans.

[23] For a critical evaluation of the national convention as a nominating agency see Clarence A. Berdahl, "Presidential Selection and Democratic Government," *Journal of Politics*, 11 (1949) : 28–41.

Secondly, the Langer plan implies the establishment of a nation-wide uniform system of suffrage qualifications. It is doubtful if the nation is ready for that step yet. Certainly objection on this ground would be sufficiently strong to defeat ratification of the proposal if it should be submitted.

Finally, abolition of the electoral vote system as a measure of state strength in the choosing of the president, which this plan would bring about, would make it unacceptable to the states which at present enjoy a relative advantage through that system. All states, it should be observed, have two electors regardless of their population, because of their having two Senators. The variation in numbers of electors from state to state comes from variation in the numbers of House seats. Hence the states of smaller population have in the electoral vote system a relatively greater weight in choosing the president than their population, in proportion to that of the more populous states, warrants. These smaller states, favored now by the electoral vote system, would undoubtedly prevent ratification of such an amendment, even if it could be passed over their protests by the requisite two-thirds majority in both houses of Congress.

The third plan now being urged upon Congress represents a compromise of a sort between the Norris and the Langer plans. It is like both of them in that it would abolish the office of presidential elector; but it would retain the electoral vote idea in a modified form. States would keep their quotas of electoral votes as determined by the numbers of their Representatives and Senators. Presidential electors as officers, however, would no longer be elected to cast a state's electoral votes. On the basis of the popular votes cast for the various candidates in a state-wide election the election officers of a state would transmit to Washington the presidential electoral vote of that state, each candidate being credited with the exact proportion of the state's electoral votes which his popular votes entitle him to. Thus in a state with 10 electoral votes a candidate who received 46.5 per cent of the popular vote would be certified as having won 4.65 electoral votes; other candidates would be credited with electoral votes in a similar way. A plurality of the electoral votes in the nation would be sufficient to elect. There would be no occasion to refer elections to the House or to the Senate.

The essential difference between this plan and the Langer direct-vote proposal lies in the fact that the popular vote is translated into the common denominator of electoral votes for ascertainment of the nation-wide result. This would preserve the present relative strength of the several states in choosing the president and at the same time permit variation in state voting qualifications without penalty of loss of strength by those states which are more conservative in setting voting qualifications. This plan thus obviates some of the major objections to the direct-vote idea, while giving effect to the principle of popular election of the president.

This proportional electoral-vote idea is not a very recent one. It was first proposed in Congress in 1848.[24] It has been carefully studied by Congressional committees and favorably reported on a number of times.[25] It has a number of champions among both parties in Congress at present, prominent among whom are Senators Lodge, of Massachusetts, and Kefauver, of Tennessee, and Representative Gossett, of Texas. Amendment resolutions embracing it have been introduced in both houses during the 1949 session of Congress and are receiving committee consideration.[26] It is very likely to come to a vote during the life of the present Congress, since it will almost certainly receive favorable committee action again in both houses as it did in the 80th Congress.[27]

EVALUATION OF THE PROPORTIONAL ELECTORAL-VOTE IDEA

Because the Lodge-Kefauver-Gossett plan gives promise of serious consideration by the Congress it merits careful analysis at this time. The points that can be advanced in its favor are numerous and weighty. It would abolish the obsolete office of presidential elector and thus eliminate the difficulties and dangers that lie in retention of this useless mechanism. It would also abandon the present majority electoral-vote requirement for determining the result of an election, thereby eliminating the necessity for resort to the present unsatisfactory method of resolving the issue when a majority electoral vote fails to materialize. Most of the evils attributed to the general ticket system of choosing electors would be either avoided or mitigated in large degree. The influence of the pivotal states and of marginal minority groups within those states on nominations, platforms, and campaign strategy would be diminished. There would no longer be reason for apathy and failure to participate in presidential elections in the so-called "sure" states. The electoral-vote results of a particular state would accurately reflect political sentiment within that state; the national electoral-vote totals would be a more accurate reflection of national political sentiment on the various candidates.[28] There would not be absolute assurance that the candidate with a plurality of the popular vote in the nation at large would also have an electoral-vote plurality; but the possibility that the winning candidate would not also be the leading candidate in terms of the total popular vote of the nation would be almost nil. The principle that it is the people and not their representatives who elect the president would be recognized. All this would be accomplished while preserving for the states their present freedom to regulate suffrage qualifications in the way they deem proper; and without disturbing the existing distribution of electoral strength among the several states.

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[24] In that year Representative Lawrence of New York introduced an amendment proposal for a proportional distribution of the electoral vote. Ames, *op. cit.*, pp. 95 ff.

[25] See *H. Rept.* 2439, 52nd Cong., 2nd Sess. (1893); *H. Rept.* 2194, 72nd Cong., 2nd Sess. (1933); *H. Rept.* 262, 73rd Cong., 1st Sess. (1933); *H. Rept.* 1615, 80th Cong., 2nd Sess. (1948); *S. Rept.* 1230, 80th Cong., 2nd Sess. (1948).

[26] S. J. Res. 2, which is sponsored by Senators Lodge of Mass., Smith of N. J., Morse of Ore., and Flanders of Vt., all Republicans, and McCarren of Nev., Fulbright of Ark., Hoey of N. C., Sparkman of Ala., Stennis of Miss., Neeley of W. Va., and Kefauver of Tenn., all Democrats, is the vehicle for this plan in the Senate. Hearings on it by a subcommittee of the Senate Judiciary Committee were conducted on March 9, 1949. Identical resolutions introduced in the House are H. J. Res. 2, by Representative Gossett of Texas, H. J. Res. 10, by Cannon of Mo., H. J. Res. 11, by Celler of N. Y., H. J. Res. 82, by Priest of Tenn., H. J. Res. 121, by Boggs of La., all Democrats; and H. J. Res. 51, by Davis of Wis., and H. J. Res. 81, by Johnson of Calif., both Republicans.

[27] EDITOR'S NOTE.—The House Judiciary Committee on April 7, 1949, voted to report the Lodge-Gossett Resolution; on the following June 13 the Senate Judiciary Committee took similar action. On February 1, 1950, the Senate passed the Lodge-Gossett amendment in slightly revised form by a vote of 64 to 27. It failed of passage in the House of Representatives on July 17, 1950, when the House voted 210 to 134 against a motion to suspend the rules and pass the proposal.

What are the arguments that will be advanced against the Lodge-Gos-

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[28] An indication of the working of the plan on the basis of the 1948 election results is shown in the following figures:

PRESIDENTIAL VOTE, 1948

Candidate	Pct. of popular vote	Actual no. of electoral votes	Actual pct. of electoral votes	Approx. no. of electoral votes under new plan	Pct. of electoral vote under new plan
Truman	49.5	303	57.1	258.1	48.6
Dewey	45.1	189	35.6	221.5	41.7
Thurmond . .	2.4	39	7.3	38.8	7.1
Wallace	2.4	...	...	10.0	1.9
Others	0.6	...	...	2.6	0.7

It should be noted that, had the new plan actually been in operation in 1948, the popular vote totals would probably have varied somewhat from those actually cast for the respective candidates.

sett plan and what validity do they have? The first that will undoubtedly be heard is that our present system has worked very well, and so there is no need for change.[29] For reasons that have already been stated above, it would appear that this is not an argument that will bear close examination. We have had at least three major presidential election crises in our history; and we have avoided others by the narrowest of margins. To those who say "Let well enough alone" the answer is, "Why wait until it rains again before we mend the leaky roof?"

The second major objection which will undoubtedly be advanced against the plan is that it will result in a multiplicity of minor parties and splinter parties, all of which will put forward presidential tickets; that it will weaken the two-party system; and, in view of the substitution of the plurality electoral-vote requirement for the present majority rule, that it will make election of "minority" presidents the rule rather than the exception. Superficially this criticism seems to carry weight. It is based on the assumption that voters of minority parties, being assured that their vote for president will be surely reflected in the electoral-vote totals, even though their numbers are hopelessly small, will be more inclined to stick with their favorites than they would under the present system. Minor parties and "splinter" groups, the argument continues, will find it less burdensome to place presidential tickets on the ballot, since there will be no need to line up an electoral slate beforehand. The presentation of many presidential tickets will cause a wider dispersion of the popular vote, it is claimed, and thus produce a winner who has a plurality which may constitute only a relatively small proportion of the total vote.[30]

These conclusions will not stand up under close analysis, however. Under the proposed plan there will actually be no more incentive for a voter to waste his ballot on some candidate who has no chance of winning than there is at present. The contest will be between the two leading candidates, as now. Only one can win. A vote for anyone other than one of the very possible winners is still a wasted vote so far as affecting the result is concerned. There is merely a shifting of the base from which the plurality rule operates to determine who wins. Now it is the winner of a popular plurality in a state who wins the prize — all the state's electoral votes. Under the proposed system the base is merely changed to the national electoral-vote total. He who gets a plurality there wins the prize — the presidency. The same considerations which now induce voters not to "waste" their votes on "also-rans" would still be operative. Elections would continue to exhibit the characteristic phenomena of past elections, with the great mass of the voters aligning themselves behind one or the other of two major-party candidates.[31]

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[29] President Truman was recently reported to have expressed this view on the subject. *New York Times,* Jan. 20, 1949, pp. 1, 4.

[30] Cf. Lucius Wilmerding, Jr., "Reform of the Electoral System," *Political Science Quarterly,* 54 (1949) : 21. This author questions the soundness of the Lodge-Gossett plan on a number of other counts also. He advocates reform along the line of requiring electors (who would still be retained) to be elected by single member districts, retaining the majority electoral vote rule as at present and submitting inconclusive elections to decision by a joint session of Congress in which Senators and Representatives would vote individually.

One further observation should be made on this point. It should not be forgotten that there are a large number of parties which put forward candidates for the presidency even under the present system. No fewer than eleven different parties formally nominated presidential candidates in 1948.[32] Three other parties endorsed candidates nominated by some one of these eleven parties.[33] Because of state laws regulating access to the ballot, only eight of the groups which nominated candidates succeeded in getting their candidates' names on the ballot in any considerable number of states. Under the Lodge-Gossett plan access to the ballot would continue to be subject to state control. It may be presumed that requirements would continue to be applied which would prevent "lunatic-fringe" groups which are numerically insignificant and latecomer "sore-head" politicians and their faithful followers from unduly burdening the ballot with the names of their candidates.

A final charge levied against the Lodge-Gossett plan is that, by embracing the idea of proportional representation, it will give impetus to the movement to adopt that system in the choosing of national, state, and local legislative bodies. It has even been suggested that a logical implication is that a national plural executive should be established.[34] This charge is wholly unfounded. It is based on a misconception of the proportional-representation aspect of the proposed plan. Proportional representation in the usual sense of the term has reference to a system of voting for members of a deliberative body or for some other similar group of individuals. Its purpose is to secure a fairly representative group with reference to the constituency to be served. The proportional representation of the Lodge-Gossett plan has no relationship to this idea or purpose. The proportional division of the electoral votes of a state is only a device for transmuting the popular votes in that state into a common political coin for counting purposes. The end sought is determination of the will of the American people on the *one* man they wish to occupy the office of president for the next four years. There is no more the aspect of a proportional-representation voting system in this than there is in the awarding of the governorship of Michigan to the individual who gets the most popular votes in a state-wide election, with the respective vote totals first being officially canvassed by counties.

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[31] Cf. the statement by Senator Lodge in answer to a number of questions regarding the effect of the proposed amendment propounded by Senator Ferguson of Michigan, *Congressional Record* (March 22, 1949), 81st Cong., 1st Sess., pp. 2891–2895.

[32] These parties were the Democratic, Republican, Progressive, States Rights Democratic, Socialist, Socialist Labor, Socialist Workers, Prohibition, Vegetarian, Greenback, and National Christian Crusade parties.

[33] The American Labor Party endorsed the Progressive candidates; the Liberal Party, the Democratic candidates; and the Communist Party, the Progressive candidates.

[34] Wilmerding, *op. cit.*, p. 6.

It is to be hoped, therefore, that the movement for reform of the present system of choosing the president along the lines proposed in the Lodge-Gossett plan will bear fruit in the near future. There is little doubt that the nation is ready for this reform. A popular-opinion poll conducted in the fall of 1948 by the American Institute of Public Opinion showed that 58 per cent of the American public favored changing the method of electing the president so that each candidate would receive the same proportion of the electoral vote of each state that he receives in the popular vote. Only 15 per cent favored maintaining the present system; 27 per cent had no opinion.[35] Even after one makes the due allowance for error in such polls which recent experience dictates should be made, the conclusion seems warranted that all that is needed to accomplish the reform is action by those who have the power to act. Here is a matter in which, by an act of prudent foresight, we can put our political house in order. By taking the appropriate steps now, in due season, we can avoid the political crisis which is certain to come, sooner or later, if we continue to rely on our present defective electoral system.

UNIVERSITY OF MICHIGAN

[35] *National Municipal Review,* 37 (1948) : 511–512.

A COMPARISON OF REPEATERS AND NON-REPEATERS AMONG BOYS IN TROUBLE WITH THE POLICE IN DETROIT IN 1946 AND 1947*

WILLIAM W. WATTENBERG

THIS report deals with the records of 2,137 boys between the ages of ten and seventeen who were "interviewed on complaint" by the Detroit police during the last five months of 1946. Of this group, on the basis of records available through the Detroit Crime Prevention Bureau and the Boys' Juvenile Bureau, it was possible to identify 672 who were again in trouble in 1947. A comparison of these repeaters with the 1,465 for whom there were no 1947 records brings to light some interesting factors related to juvenile misconduct.

Properly speaking, the boys were not necessarily all "delinquents" as the term is used legally or as it is employed in most sociological studies. Only a small proportion were referred to the juvenile court; approximately two thirds were released to their parents by the police at the local precinct station.

Most workers in the field of delinquency have emphasized that young people who reach the courts are a selected group of all young people who have engaged in illegal or antisocial acts. Selective factors operate at each step. To be referred to the court the young offender must (1) be caught, (2) have impressed neighbors, victims, or police officers as having been guilty of offenses sufficiently serious to be brought to police attention, (3) have left the police officers convinced that the best way of handling his case is to file a formal complaint, and (4) upon investigation by court workers, be regarded as sufficiently serious to warrant official action. There is a suspicion that offenders gifted with intelligence or coming from families of good social position can either escape detection

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*I wish to express my appreciation to Commissioner Harry S. Toy, Inspector Sanford Shoults, Lieutenant Ralph Baker, and Sergeant Frances Davey, all of the Detroit Police Department, for their aid in collecting and tabulating the basic data and for permission to use them.

or, if arrested, be more easily rescued from the usual legal processes by their parents.

For these reasons it is considered desirable to study groups as far forward in this chain of events as possible. The Detroit group meets this need. It consists of all boys who were brought to precinct stations as a result of complaints made by anyone during the period under study.

A special procedure has been established by the Police Department for processing cases involving boys between the ages of ten and seventeen. At each station there are Crime Prevention Bureau officers to whom all boys are turned over for study and recommendation. To aid them in the investigation these officers are provided with a report form, called a history sheet, on which they are asked to record a wide variety of information concerning the boy, his family, his recreational activities, and other pertinent data. The officers generally visit the home and interview the parents before filling out the form. The history sheet for the more serious offenses is completed by specially trained detectives in the Boys' Juvenile Bureau.

Since this article is based on the history-sheet data, readers should be given as realistic an evaluation of these report forms as can be made. In the thinking of the police officials who inaugurated the history sheet, the primary purpose was education of the officers dealing immediately with boys. It was felt that, in order to fill out the blank, the men would have to acquire information which would make for wiser disposition of each case. But the policemen who filled out the sheets have found that some sections yield information which helps them solve later cases. These items, such as nicknames, pals, and the like, they record with great care. The recording of other items some of the men are inclined to regard as a chore. The research use of the records was considered from the start, but it has always been secondary to the police needs.

The items themselves vary considerably in objectivity and in the definiteness of the categories. Some, such as the number of siblings and family ownership of cars, are clear-cut and objectively ascertainable. Others call for subjective ratings of such things as congeniality of the family group. There are items for which the knowledge that a policeman accumulates in the neighborhood he patrols could not be bettered by any outside investigator. Still others are more in the province of trained case workers and similar interviewers.

In any event, the information recorded was coded for punching on International Business Machine cards. For the purposes of the present study all cards for the initial contact with the 2,137 boys who came to police attention during the last five months of 1946 were used. It should be noted that the records were completed before there was any way of knowing which boys would be repeaters. This method eliminated any possibility that the results might be altered, even unconsciously, to help them fit any person's pet theories. Each boy was given a serial number.

Early in 1948, more than a full year after the original records had been completed, all the cards representing the contacts of the Crime Prevention Bureau and the Boys' Juvenile Bureau with boys in 1947 were sorted on the basis of serial numbers to locate those for whom there had been a 1946 contact. All such cases in the original group of 2,137 were set aside. They numbered 672 and constitute our group of repeaters.

The remaining 1,465 boys were classed as nonrepeaters. There is reason for believing, however, that this group contained some boys from three categories in addition to those for whom the designation "nonrepeater" is appropriate. All three contaminating groups were probably small, but accuracy demands that they be reported. They are as follows: (1) a few boys who may have been arrested in 1947 after having passed their seventeenth birthdays and who, therefore, were not recorded as juvenile cases; (2) a small number who spent all or part of 1947 in penal institutions and who might have been repeaters if at liberty; and (3) several who may have moved into other jurisdictions and have been apprehended for violations there.

Once the division into repeaters and nonrepeaters was completed, the problem was dealt with in a purely empirical manner. For every item of recorded information, regardless of any opinion as to its reliability or probable significance, a tabulation was prepared and submitted to the chi-square test. Three typical tabulations are presented in Tables I, II, and III. It will be noted that the "no statement" category is included in the computation. This has the effect of adding one to the degrees of freedom in the table. In most instances the result is an increase in the chi-square total required for statistical significance. As a consequence, the computations err somewhat in the direction of conservatism. Internal evidence justifies this treatment of the "no statement" category because sometimes — for example in regard to employment of the parents — failure of the police officer to obtain the information may be significant. Concerning that item there is reason to believe that the "no statement" group included parents who were engaged in illegal or low-status jobs.

The chi-square test enabled us to divide the items into three groups:

(1) Those, such as the item treated in Table I, which were significant at the one per cent level. The members of this group are listed in Table IV as "significant."

(2) Those, such as the item treated in Table II, which were significant at the five per cent level of confidence but not at the one per cent level. The members of this group are listed in Table IV as "borderline."

(3) Those, such as the item treated in Table III, which failed of significance at the five-per-cent level. The members of this group are listed in Table IV as "inconclusive."

One might define the significant items as those which distinguish between boys who get in trouble only once and boys who are repeatedly in trouble. In this sense the items are presumably predictive of the probability of future wrongdoing by boys who have already committed one offense. They are, therefore, of special interest to students of delinquency as representing conditions which either cause juvenile misconduct or are associated with the causes.

TABLE I

RELATIONSHIP BETWEEN REPEATING AND RACIAL HOMOGENEITY OF NEIGHBORHOOD

Racial character of neighborhood	Total	Number		Percentage	
		Repeaters	Nonrepeaters	Repeaters	Nonrepeaters
Racially the same	1,781	533	1,248	79.3	85.2
Racially mixed . .	323	128	195	19.1	13.3
No statement . . .	33	11	22	1.6	1.5
Total	2,137	672	1,465	100.0	100.0

$X^2 = 12.02 \quad \underline{n} = 2 \quad \underline{P} < 0.01$

Table IV indicates the significance of the items in relation to repeating. It reveals some relationships which are familiar to sociologists and which harmonize with scientific theories as well as with common-sense expectations. Other relationships point to factors which have not been heavily stressed, although none run counter to previous studies or to popular opinion. The striking surprises are found among the inconclusive items, which seem to indicate that some factors are less powerfully operative than they are generally supposed to be.

TABLE II

RELATIONSHIP BETWEEN REPEATING AND POSSESSION OF RECREATIONAL EQUIPMENT

Possession of recreational equipment comparable to that of playmates	Total	Number		Percentage	
		Repeaters	Nonrepeaters	Repeaters	Nonrepeaters
Yes	1,481	444	1,037	66.1	70.7
No	636	222	414	33.0	28.3
No statement ...	20	6	14	0.9	1.0
Total	2,137	672	1,465	100.0	100.0

$X^2 = 6.48 \quad \underline{n} = 2 \quad 0.05 > \underline{P} > 0.01$

TABLE III

RELATIONSHIP BETWEEN REPEATING AND NUMBER OF BROTHERS

Number of brothers	Total	Number		Percentage	
		Repeaters	Nonrepeaters	Repeaters	Nonrepeaters
0	543	165	378	24.5	25.9
1	625	179	446	26.6	30.5
2	466	151	315	22.5	21.4
3	350	118	232	17.6	15.8
4	96	38	58	5.7	4.0
5	32	14	18	2.1	1.2
6	16	4	12	0.6	0.8
7	6	2	4	0.3	0.3
8	3	1	2	0.1	0.1
Total	2,137	672	1,465	100.0	100.0

$X^2 = 9.42 \quad \underline{n} = 7 \quad 0.50 > \underline{P} > 0.30$

TABLE IV

SIGNIFICANCE OF ITEMS IN RELATION TO REPEATING

Significant items	Borderline items	Inconclusive items
1. Condition of building occupied by family	1. Type of dwelling unit	1. Functional homogeneity of neighborhood
2. Adequacy of size of dwelling unit, as judged by police officer	2. Hobbies	2. Nature of nearest recreational facility
3. Racial homogeneity of neighborhood	3. Recreational equipment	3. Favorite sports
4. Quality of neighborhood, as judged by police officer	4. Parents' attitude toward police	4. Membership in youth-serving organizations
	5. Marital status of parents	5. Amount of employment
	6. Expressed attitude toward father alone	

Significant items	Inconclusive items
5. Frequency of church attendance	6. Chores around home
6. Attitude toward school	7. Parents' method of giving money
7. Things disliked about school	8. Disposition of earnings
8. Type of employment	9. Purpose of expenditures
9. Money received from parents	10. Membership in "gangs"
10. Type of entertainment on which money was spent	11. Congeniality with other boys
11. Adequacy of family income, as estimated by police officer	12. Attitude toward adult neighbors
12. Family ownership of automobile	13. Nicknames
13. Number of sisters	14. Attitude toward nicknames
14. Intelligence, as judged by police officers	15. Parents' employment
15. Attitude toward police officers	16. Permission to drive family car
16. Expressed attitude toward parents	17. When parents are at home
17. Neatness of appearance	18. Participation of parents in activities
18. "Type" of boy	19. "Picking on" by members of family
19. Congeniality of family, as judged by police officer	20. Sharing of family problems
	21. Chronic illness in family
	22. Number of brothers
	23. Being an "only child"
	24. Sex distribution of siblings
	25. Expressed attitude toward home
	26. Expressed attitude toward mother alone
	27. Physical development
	28. Sexual development
	29. Alcoholism in family

NOTE — The detailed tables have been published in a mimeographed report entitled *Boy Repeaters*, copies of which may be secured by writing to the Commissioner of Police, Detroit Police Department, 1500 Beaubien, Detroit 31, Michigan.

For convenience, the items are discussed below in clusters which have sociological or psychological elements in common. No merit other than convenience can be claimed for these groupings. It would be interesting at some time in the future to make a factor analysis. I feel, however, that the order of reliability of the present data will easily support a chi-square analysis, but that it would be too weak for tetrachoric correlations, variance analysis, or similar refined techniques.

The analyses show the expected and familiar relationship between delinquency and neighborhood conditions. The repeaters came more frequently than the nonrepeaters from neighborhoods judged "poor." They lived more often in buildings which were substandard or needed repairs and which were considered too small by police officers. They were a higher proportion of the boys living in flats rather than in single-family homes. Partly confirming the conclusion they were recruited from areas undergoing invasion was the fact, shown in Table I, that a larger proportion came from racially mixed neighborhoods. The question of mixture of residential and commercial land uses was, however, an inconclusive item. These results may be a product of the unusually broken pattern of land use in Detroit.

In all these respects, as well as in those to be discussed later, the differentials between repeaters and nonrepeaters are of the magnitude illustrated in Table I. Differences ranging from 5 to 10 per cent are most frequent. But although differences of that order of magnitude will be statistically reliable, substantial numbers of nonrepeaters come from unfavorable situations, and large numbers of repeaters come from favorable ones. In no relationship did we find an item which in and of itself separated the two groups without a preponderance of overlap.

Related to the neighborhood conditions was the economic status of the family. Two items bearing on this element were among the significant ones: (1) adequacy of family income and (2) family ownership of a car. The second item proved to be one of the strongest in discriminating between the two groups: 27.2 per cent of the repeaters came from families owning automobiles, but 41.7 per cent of the nonrepeaters came from such families. It is probable that this item reflects factors other than the purely economic. Some of these will be considered later. One economic item, the employment status of the parents, was inconclusive.

Findings on the economic status of a boy were not very clear-cut. Money received from parents was significant because of a heavy proportion of nonrepeaters falling into the "no statement" category. When this category was eliminated the item became inconclusive. The possession of recreational equipment equivalent to that of a boy's playmates was a borderline item. From these facts it is safe to say that juvenile misconduct in Detroit is not generally a direct attempt to solve a need for playthings or for money.

Attitudes toward adult institutions, by contrast, were highly important. Frequency of churchgoing was significant. So were attitudes toward school and the things disliked in school. Seventeen per cent of the repeaters, as compared with 10 per cent of the nonrepeaters, said they disliked the subjects taught. That this may reflect the school system's failure to meet individual needs is suggested by the fact that mental level, as rated by the officers, was also a significant item.

Spare-time activities were much less of a factor than most believers in recreation or most persons of "the devil finds work for idle hands" school of thought would like to believe. The kind of employment was a significant item, but analysis showed two facts responsible for this: (1) store clerks tended to be repeaters; (2) newsboys were 50 per cent more numerous among nonrepeaters. However, 10 per cent of the combined groups were newsboys, indicating a probability that the conditions of employment were detrimental but that the kind of boy who would do the work of running a paper route is not prone to continue misconduct. One recreational item was significant: the type of entertainment on which the boys spent their money. Here the differentiation effect was traced to the high proportion of repeaters spending money on commercial recreation, such as pool or bowling. Since the presence of minors in many establishments offering such recreation is illegal, this does not seem very surprising.

Pursuit of hobbies was a borderline item; 45 per cent of the repeaters had no hobby, but only 40 per cent of the nonrepeaters had none. The hobby which showed greatest difference between the groups was, of all things, collecting. The proportion of collectors among the nonrepeaters was almost twice that among the repeaters.

All other items having to do with the amount of spare time were inconclusive. Present in this rather unexpected array were the following: (1) the nature of the nearest recreational facility; (2) favorite sports; (3) membership in youth-serving organizations; (4) the amount of time spent in employment outside school; and (5) the amount of time devoted to chores around the house.

Objective family constellation exhibited only one significant item:

the number of sisters. Repeaters evidenced a significantly higher proportion of boys from homes with three or more sisters. A similar analysis based on the number of brothers proved inconclusive. Other items falling in the inconclusive group were whether or not the boy was an only child and the sex distribution of siblings. The effect of broken homes was not so heavy as many would predict, for the marital status of parents was a borderline item. The presence of chronic illness and addiction to alcohol were inconclusive items.

Family morale, on the other hand, showed up very strongly. This was all the more surprising as local critics of the Detroit Crime Prevention Bureau had based their arguments on the assumption, which did seem reasonable at the time, that policemen would not be so sensitive to emotional factors in the home as social workers or other trained interviewers. The policemen's estimate of uncongeniality proved a significant item; the proportion of boys from uncongenial homes was 11.5 per cent for repeaters and 6.5 per cent for nonrepeaters.

Competence in managing the family, its possessions, and its income is reflected by the finding that a boy's neatness of appearance, the state of repairs of the home, and the possession of an automobile were all significant.

Preference between the adults, as evidenced by a boy's statement that he liked his mother but disliked his father, appeared more frequently among the repeaters. Although this combination was a significant item, expressed attitude toward the father alone was a borderline item, and expressed attitude toward the mother alone was an inconclusive item. The feeling of being "picked on" at home was another inconclusive item, as was also the overall attitude expressed toward the home.

Techniques of child rearing and of family management of the type dear to writers for parents' magazines did not fare so well. None turned up in either the significant or the borderline items. The following were all inconclusive: (1) the methods used by the parents in giving money to the boys (whether by allowance, or on request, or for work done around the house); (2) the participation of the parents in the recreational activities of their children; (3) the time of day when parents were at home; (4) permission to drive the family car; and (5) the sharing of family problems. This fact would seem to verify the suspicion of many psychologists that the basic relationships within the home are more important than domestic routines, which may vary from one subculture to another.

Reactions evoked by the boys, as indicated by personality ratings, proved to be quite significant. There were four items on which the policemen were asked to give ratings: (1) intelligence, (2) "type," (3) attitude toward the policemen themselves, and (4) attitude toward adult neighbors. Psychological research has shown that such judgments are extremely liable to the "halo effect." Boys who create a good general impression are rated higher than they would be by a more objective procedure. Therefore the ratings are as much a measure of the policemen's attitudes toward the boys as of the boys themselves. It is interesting that three of these four ratings were significant items.

Boys judged as below average in mentality and as "evasive" toward the police were found significantly more often among the repeaters. In regard to "type," four categories were derived from the analyses: (1) studious, (2) quarrelsome, (3) "Peck's bad boy," and (4) normal. Obviously, these categories cannot be defended on the basis of any known sociological or psychological theory. It is especially interesting, then, to find that they should prove to discriminate highly between repeaters and nonrepeaters. The police classed as "studious" 1.8 per cent of the repeaters and 3.8 per cent of the nonrepeaters. In the "Peck's bad boy" grouping were placed 24.7 per cent of the repeaters, but only 15.9 per cent of the nonrepeaters.

Such findings suggest the possibility that "delinquency" sometimes represents an adult pattern of reaction *to* a youngster rather than a pattern of behavior *in* the young person. When a boy already has a bad reputation or has created a poor impression, acts which might be excused in a "good" child may be more noticed by adults, especially by the police on the beat, and be treated more seriously. Also, such a child would be more likely to be suspected of wrongdoing and picked up on suspicion, whereas others could escape the consequences of misdeeds because they were not suspected. This is a matter which could well be the subject of research in other places.

Miscellaneous inconclusive items make up the rest of the list. They are: (1) membership in neighborhood gangs; (2) congeniality with other boys; (3) nicknames; (4) attitude toward nicknames; (5) physical development; and (6) sexual development.

That membership in neighborhood gangs (with "gang" defined as a group of four or more boys who spend most of their spare time in one another's company) and congeniality with others should prove inconclusive was somewhat surprising. The fact that physical items proved poor predictors is, however, just one more piece of evidence strengthening the case against biological theories of delinquency.

SUMMARY

This study took as a base population all boys in Detroit brought to police attention on complaint during the last five months of 1946. Records for 1947 permitted them to be divided into repeaters and nonrepeaters. A comparison of the two groups was made to determine what factors discriminated between them. The research differs from others in the field in that it studied "delinquents" at two points in their development rather than when they had matured into offenders who had to be accorded legal attention in courts or institutions.

The findings, however, illustrate very well the now familiar thesis that "delinquency" is a complex phenomenon representing the interplay of many sociological and psychological forces. No single factor stands out as *the cause.* The effects of local subcultures, symptomized by socioeconomic indices, are clearly very powerful. So also are the effects of intrafamily relationships, shown by the items reflecting family morale. In addition, such matters as adjustment to school, religious feelings, and the reaction of adults to the youngsters' personalities are significant in the development of more than a few boys.

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